

Research on the Optimization and Practice of High School Chemistry Experiment Teaching under the New Curriculum Standard

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Abstract: With the implementation of the new curriculum standards, the importance of high school chemistry experiment teaching in promoting students' scientific literacy and comprehensive abilities has become increasingly prominent. However, traditional experimental teaching methods face numerous challenges in meeting the requirements of the new curriculum and in motivating students' learning interest. This paper analyzes the current status of high school chemistry experiment teaching based on the requirements of the new curriculum standard and proposes optimization strategies and practical pathways for experimental teaching, with a focus on the design of inquiry-based experimental activities, the application of modern educational technology, and personalized teaching methods. Through practice evaluation and reflection, this paper summarizes the future directions for improving high school chemistry experiment teaching, aiming to provide valuable references for enhancing the quality of chemistry education.

Keywords: New curriculum standard; high school chemistry; experimental teaching; optimization strategies; inquiry-based experiment

1. Introduction

With the gradual implementation of the new curriculum standards in China, high school education faces increasingly diversified and personalized teaching demands, highlighting the importance of high school chemistry experiment teaching. Chemistry experiments are a crucial part of chemistry learning, not only helping students to understand chemical knowledge intuitively, cultivate their hands-on abilities and scientific inquiry literacy, but also stimulate their interest in learning chemistry. However, traditional high school chemistry experiment teaching still has many shortcomings in terms of teaching methods, content design, and student engagement. These aspects fall short of the new curriculum's emphasis on cultivating core competencies and innovative abilities. The existing teaching model mainly focuses on theoretical instruction, with experimental sessions becoming more of a formality, failing to meet the new curriculum's requirements for cultivating students' comprehensive capabilities. In this context, optimizing high school chemistry experiment teaching has become a key issue for educators. This study starts from the new curriculum's requirements for chemistry experiment teaching, analyzes the current problems and shortcomings in experiment teaching, and explores effective teaching optimization strategies. By constructing inquiry-based experimental activities, applying modern educational technology, and enhancing student engagement and learning outcomes, we hope to provide valuable references and guidance for high school chemistry teaching, thereby promoting the effective implementation of the new curriculum concepts. This paper will begin with the basic requirements and characteristics of the new curriculum standard, combined with practical strategies and effect evaluations, to propose directions for future optimization of high school chemistry experiment teaching, aiming to contribute to improving teaching quality and cultivating students' comprehensive abilities[1].

2. Requirements and Characteristics of High School Chemistry Experiment Teaching under the New Curriculum Standard

2.1. Basic Requirements and Teaching Philosophy of the New Curriculum Standard

The new curriculum standard emphasizes a student-centered approach, focusing on cultivating students' scientific literacy, inquiry ability, and innovative thinking. For high school chemistry

experiment teaching, the new curriculum proposes higher requirements, emphasizing that experiment teaching must go beyond traditional "verification experiments" to "inquiry-based experiments," which focus on fostering students' independent thinking and practical abilities during the experiment process. The new curriculum requires chemistry experiment teaching to encompass the three-dimensional goals of scientific inquiry, processes and methods, and emotional attitudes and values, enabling students to not only grasp foundational knowledge but also develop scientific thinking habits and problem-solving skills. In terms of specific teaching philosophy, the new curriculum advocates for comprehensive and innovative experiment teaching. Teachers should focus on guiding students to participate in the design and execution of experiments, allowing them to understand the fundamental principles and essence of chemical reactions through hands-on practice. Additionally, the new curriculum emphasizes integrating experiment teaching with real-life situations, enabling students to gain a deeper understanding of natural laws and societal issues through chemistry experiments. Moreover, the new curriculum encourages teachers to utilize modern teaching tools such as information technology and digital tools to enrich experiment content and enhance teaching efficiency, making experiment teaching more vivid, intuitive, and effective. This philosophy aims to break the monotony and rigidity of traditional experiment teaching, thereby enhancing students' interest in learning and fostering their ability for independent inquiry, ultimately achieving a comprehensive improvement in the quality of chemistry education[2].

2.2. Importance and Changes in Chemistry Experiment Teaching under the New Curriculum Standard

Chemistry experiment teaching holds an irreplaceable position in high school chemistry education. Experiments are not only a practical component of learning chemical knowledge but also a key pathway for cultivating scientific literacy and practical abilities. Through experiment teaching, students can transform abstract chemical theories into concrete experimental phenomena, thereby deepening their understanding and retention of knowledge. During experiments, students develop observation skills, thinking abilities, and problem-solving capabilities, all of which are crucial for enhancing their overall competence. Chemistry experiments also stimulate students' interest in learning, cultivate a spirit of scientific inquiry, and promote teamwork skills, laying a solid foundation for future learning and career development. Under the new curriculum standard, chemistry experiment teaching has undergone a series of important changes[3]. Firstly, the new curriculum places greater emphasis on the inquiry-based and practical nature of experiment teaching, requiring teachers to design open and comprehensive experimental activities that cultivate students' independent inquiry abilities and innovative thinking. Experiments are no longer confined to verifying textbook theories but guide students to pose questions, design experimental plans, analyze results, and draw conclusions. Secondly, the new curriculum stresses the integration of experiment teaching with real-life scenarios, allowing students to see the importance of chemistry in daily life and societal development, thereby enhancing the practical relevance and appeal of learning. Additionally, the introduction of modern information technology has brought innovative forms of experiment teaching. By using virtual laboratories and digital platforms, teachers can showcase complex experimental phenomena and processes, offering students a richer learning experience. These changes make chemistry experiment teaching more diverse, flexible, and efficient, better meeting students' personalized learning needs and comprehensively enhancing their capabilities[4].

2.3. Current Status and Challenges in High School Chemistry Experiment Teaching

High school chemistry experiment teaching has achieved certain successes in practice but still faces numerous real-world challenges. Firstly, insufficient resources and equipment are prevalent in many schools, especially in underdeveloped regions where outdated or insufficient chemistry experiment equipment hampers the diverse and innovative experiment requirements of the new curriculum. The lack of sufficient experimental tools and resources limits teachers' ability to design effective experiment lessons, impacting students' practical and inquiry activities. Secondly, some teachers still have limitations in understanding and implementing experiment teaching concepts[5]. Traditional "verification experiments" continue to influence teaching practices, with teachers focusing more on verifying results rather than encouraging inquiry during the experiment process. This teacher-centered approach fails to fully empower students and hinders the cultivation of their innovative and scientific inquiry skills. Furthermore, due to work pressure or limited teaching experience, some teachers are unable to effectively use modern information technology and digital tools to innovate their teaching, resulting in monotonous lessons and limited student engagement. In addition, experiment safety management and time allocation pose significant challenges. Chemistry experiments inherently carry risks and require strict management and operational norms, while some schools lack sufficient investment in safety management and training,

leading to potential hazards or operational errors. At the same time, tight high school course schedules and limited experiment class hours fail to meet the new curriculum's requirements for inquiry-based experiments and deep learning, further restricting effective experiment teaching. Overcoming these challenges requires collective efforts from educators to optimize resource allocation, innovate teaching methods, and strengthen teacher training, ultimately enhancing the quality and effectiveness of high school chemistry experiment teaching.

3. Strategies and Practices for Optimizing High School Chemistry Experiment Teaching

3.1. Optimizing Experiment Design and Teaching Methods

To improve the quality of high school chemistry experiment teaching, it is essential to systematically optimize experiment design and teaching methods, with a focus on cultivating students' independent inquiry abilities and innovative thinking. Firstly, teachers should emphasize inquiry-based and open-ended experiment designs. Traditional verification experiments primarily aim to confirm established theories, whereas inquiry-based experiments encourage students to propose hypotheses, design experimental plans, and verify them through experimentation. This approach not only helps students master experimental techniques but also fosters independent and critical thinking. For example, teachers can encourage students to choose their own topics, design various experimental approaches around chemical reaction principles, and derive conclusions through data analysis. Secondly, experiment teaching should integrate real-life scenarios to enhance students' interest and practical skills. Teachers can introduce everyday phenomena into chemistry experiments, such as "water quality testing" or "analysis of food acidity," enabling students to discover the close relationship between chemistry and daily life. This type of practical problem-based experiment teaching helps improve students' overall competence and application abilities, motivating them to engage more deeply with chemistry learning. In addition, the application of modern information technology is a crucial tool for optimizing experiment teaching[6]. Teachers can use digital laboratories, virtual reality, and simulation software to provide students with multidimensional experimental experiences. Virtual experiments break the constraints of time and space, allowing students to observe and analyze experimental processes more intuitively, especially in situations where hands-on practice is limited. Moreover, through modern multimedia technologies, teachers can offer real-time demonstrations and interactions, enhancing the vividness and clarity of experiments and making the teaching content more engaging and impactful. Overall, optimizing experiment design and teaching methods requires a focus on inquiry, real-life integration, and modernization to make chemistry experiment teaching more attractive and effective.

3.2. Enhancing Experiment Teaching Effectiveness with Modern Educational Technology

The rapid development of modern educational technology has created new opportunities and vast potential for high school chemistry experiment teaching. By effectively using informational tools and technologies, teachers can significantly enhance the effectiveness of experiment teaching and improve students' learning experiences and comprehension. Firstly, digital laboratories and virtual reality technology greatly enrich the forms of experiment teaching. Using virtual experiment software and simulation platforms, students can simulate real chemistry experiments in a digital environment, observe experimental phenomena and reactions, and overcome the limitations of time, space, and safety inherent in traditional experiments[7]. Virtual experiments not only help students master complex experimental steps and principles but also enable them to gain experience through repeated practice, enhancing their operational skills. Additionally, modern educational technology supports more diverse and interactive experiment teaching activities. With multimedia presentations and online teaching tools, teachers can clearly demonstrate key steps and principles in experiments, deepening students' understanding of knowledge. For example, teachers can use animations, videos, and interactive learning platforms to guide students in analyzing experimental phenomena, helping them grasp chemical reaction processes that are difficult to present through traditional teaching methods. By incorporating interaction and real-time feedback, students can adjust and refine their operations and thought processes during experiments, increasing their learning initiative and engagement. Moreover, the introduction of data recording and analysis technology provides new tools for experiment teaching. During experiments, students can use sensors and data collection devices to record experimental data in real-time, then analyze and process the data using computers. This data-driven experimental approach allows students to understand the dynamic changes and patterns of chemical reactions more accurately. Through data analysis, students can conduct deeper investigations and draw conclusions, enhancing their scientific literacy and logical thinking skills.

In summary, the application of modern educational technology not only makes high school chemistry experiment teaching more diverse and engaging but also significantly improves the quality and effectiveness of experiment teaching, supporting the cultivation of innovative and highly capable chemistry talents[8].

4. Evaluation and Reflection on the Effectiveness of Optimization Practices

4.1. Feedback and Data Analysis from Classroom Practices

In the process of optimizing high school chemistry experiment teaching, feedback and data analysis from classroom practices play a vital role in evaluating teaching effectiveness. By systematically analyzing students' experiment processes and results, teachers can objectively assess the impact of optimization strategies and make targeted improvements. Firstly, teachers can observe students' performance during experiments, such as their proficiency in operations, improvements in inquiry skills, and collaboration and communication within groups, to gain an initial understanding of the effectiveness of optimization measures. Additionally, classroom feedback through surveys and interviews provides a crucial means of collecting students' opinions. By listening to students' feedback, teachers can understand their interests, challenges faced during experiments, and suggestions for teaching methods, which can further guide adjustments and improvements in teaching strategies. Data analysis serves as another important evaluation tool[9]. Teachers can regularly collect data on students' experiment results, operational records, and experiment reports, combining this data with test scores, classroom performance, and other metrics for comprehensive analysis. By statistically analyzing and comparing the data, teachers can determine the impact of optimization measures on students' performance and abilities. For example, they can assess the influence of inquiry-based experiments on students' creative thinking or analyze the changes in teaching effectiveness achieved through modern information technology. By combining quantitative data on students' improvements before and after experiments, teachers can better gauge the actual effectiveness of optimization practices and formulate the next steps for teaching strategies accordingly. Through feedback and data analysis from classroom practices, teachers can continually refine and improve experiment teaching strategies to better meet students' needs and the requirements of the new curriculum. This iterative process not only enhances the quality of chemistry experiment teaching but also provides a scientific basis and empirical support for subsequent teaching reforms, driving the overall improvement of teaching standards[10].

4.2. Challenges and Solutions in the Optimization Process

Despite the application of many new strategies and technological tools in the optimization of high school chemistry experiment teaching, various challenges and difficulties still arise, requiring targeted solutions. Firstly, the lack of experiment resources is a prominent issue, particularly in underdeveloped areas where outdated or insufficient laboratory equipment and materials severely limit the effectiveness of experiment teaching. To address this issue, schools and educational authorities need to increase funding and improve laboratory infrastructure. Additionally, resource-sharing mechanisms, such as regional experiment resource centers and online experiment platforms, can expand access to experiment resources, ensuring that every student has the opportunity to engage in experiments. Secondly, the proficiency of teachers in experiment teaching and their familiarity with information technology significantly impact the effectiveness of optimization efforts. Some teachers may lack the skills to apply modern educational tools flexibly in the classroom. Schools should therefore enhance teacher training, providing more opportunities for learning and practice to improve teaching skills and foster innovation. Collaboration and experience-sharing among teachers through workshops and professional discussions can also help build a supportive environment for exploring and exchanging optimization strategies for experiment teaching. Moreover, safety issues in experiment teaching must be addressed as an essential challenge. Chemistry experiments carry inherent risks, and ensuring student safety is of paramount importance. Schools need to strengthen safety education to raise students' awareness and provide comprehensive training for teachers in safety management. During the design of experiment teaching plans, potential risks should be carefully considered to ensure that experiment steps are standardized and well-ordered, with appropriate protective measures and guidance provided. By standardizing procedures and reinforcing safety management, schools can effectively mitigate risks and ensure a safe and enriching experiment experience for students. Finally, limited time and class periods pose additional constraints on experiment teaching optimization. With tightly packed schedules, many schools struggle to allocate sufficient time for comprehensive inquiry-based experiments. To overcome this challenge, teachers can

flexibly adjust their teaching plans by integrating some experiment content with theoretical lessons or organizing after-class experiment activities for students. By making efficient use of available time resources, teachers can maximize students' opportunities to engage in experimental learning and better achieve the goals of the new curriculum. These challenges require collective efforts, innovative thinking, and continuous improvement to overcome, ultimately driving high-quality development in high school chemistry experiment teaching.

5. Prospects for Future High School Chemistry Experiment Teaching

5.1. Exploring Innovative and Up-to-Date Experiment Teaching Models

With the continuous evolution of modern educational concepts, high school chemistry experiment teaching requires constant innovation and exploration to stay current, better aligning with the requirements of the new curriculum standards and student needs. Future teaching models should place a stronger emphasis on student-centered approaches, highlighting their active role and engaging their interest and inquiry passion through diverse and flexible experiment formats. For example, a project-based learning approach can integrate experiment content with real-life and societal issues, enabling students to deeply understand chemical principles through the process of solving real-world problems. This contextual and task-driven learning model helps cultivate students' comprehensive competencies and innovative abilities. As technology advances, information technology will further support experiment teaching. The introduction of virtual laboratories, augmented reality, and artificial intelligence can break the traditional limitations of time and space in experiment teaching, allowing students to experience authentic experimental processes in virtual environments. Through simulation and modeling technologies, students can perform multiple operations, observe experimental phenomena and variable changes, and enhance the accuracy and scientific rigor of their experiment skills. Moreover, intelligent experiment platforms based on data collection and analysis can provide real-time feedback on students' experiment results and performance, enabling teachers to adjust their teaching strategies promptly and offer personalized guidance and support for each student. Future experiment teaching models should also place greater emphasis on collaboration and communication, encouraging students to work in groups and engage in discussions to complete experiment tasks together. This approach not only develops teamwork and communication skills but also stimulates innovative thinking through diverse perspectives. During experiments, teachers should focus on providing guidance and support, offering appropriate assistance to foster students' abilities in independent inquiry and problem-solving. In summary, exploring innovative and up-to-date experiment teaching models requires continuous optimization through practical application, the use of new technologies, promotion of contextual learning, and a combination of personalized and collaborative teaching. These approaches can comprehensively enhance students' chemistry literacy and overall abilities, contributing to the educational goals of the new era.

5.2. The Importance of Continuous Improvement and Teacher Training

Continuous improvement and teacher training play a crucial role in optimizing and advancing high school chemistry experiment teaching. Improving teaching quality is a long-term process that requires ongoing experience review, problem identification, and targeted improvement. Optimizing chemistry experiment teaching must keep pace with the development of educational concepts and technological methods, necessitating continuous reflection and innovation by teachers in their teaching practices. Through regular classroom feedback, data analysis, and discussion workshops, teachers can understand students' needs and challenges in experiment learning, adjust teaching strategies accordingly, and explore more effective teaching methods. Continuous improvement is essential for maintaining the vitality and effectiveness of experiment teaching, enabling teachers to better meet the requirements of the new curriculum standards. In addition, teacher training is equally critical in experiment teaching. The optimization of chemistry experiment teaching and the integration of new technologies place higher demands on teachers' professional skills. Teachers not only need a solid foundation in chemistry knowledge and experimental operation skills but also require proficiency in modern educational technology. Systematic training and professional learning enable teachers to master the latest teaching tools and methods and apply them flexibly in classroom practices. For example, using information technology for experiment data analysis and conducting teaching with virtual experiment platforms require training to enhance teachers' application skills. Furthermore, teacher collaboration and exchange can be strengthened through training and workshops, allowing teachers to share practical experiences, discuss teaching challenges, and collectively improve the level of experiment teaching. Teachers'

comprehensive quality and professional capabilities directly impact the effectiveness of chemistry experiment teaching. Only through continuous training and practice can teachers improve their own skills, better inspire students' interest and inquiry abilities, and achieve high-quality chemistry education. Therefore, schools and educational authorities should increase investment in teacher training, providing necessary support and resources to promote continuous progress and innovation in chemistry experiment teaching, ensuring that students grow and develop in a high-quality educational environment.

6. Conclusion

In the context of the new curriculum standards, the importance of high school chemistry experiment teaching has become increasingly prominent. It serves as an effective way to help students master chemical knowledge and a key means of cultivating their scientific inquiry spirit, innovative thinking, and practical abilities. By analyzing the current status and challenges in chemistry experiment teaching, we recognize the need for continuous optimization and innovation in traditional teaching models to meet the requirements of the new curriculum for comprehensive student development. This paper proposes strategies for optimizing experiment design and teaching methods, leveraging modern educational technology to enhance teaching effectiveness, and emphasizes the necessity of evaluating classroom practice outcomes and continuous improvement. Future chemistry experiment teaching should focus on exploration and innovation, flexibly applying modern technologies to provide students with richer and more engaging experimental experiences. Continuous teacher training and skill enhancement are also crucial. Through ongoing learning and innovative practices, teachers can better realize the value and impact of experiment teaching. With collective efforts and continuous improvement, we hope to achieve high-quality development of high school chemistry experiment teaching, supporting students' comprehensive growth and the full implementation of the new curriculum standards.

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