The Practice of Integrating Traditional Culture Empowerment with AI technology in High School Chemistry Teaching

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Abstract. Classical literary works contain abundant life-oriented and context-based teaching resources, serving as high-quality carriers for implementing subject-based education and innovating classroom models. In the context of educational digital transformation and the implementation of core chemical literacy, traditional high school organic chemistry introductory teaching has many problems such as abstract microscopic knowledge, insufficient student exploration, shallow thinking, and disconnection from context-based education. The teaching model of "literature context + AI empowerment + thinking advancement + literacy implementation" can achieve the deep integration of traditional culture, digital technology, and subject teaching, efficiently fulfilling the cultivation goals of core chemical literacy, and providing a replicable practical sample for innovative teaching of high school organic introductory courses.

Keywords: ethanol; traditional culture; thinking class; artificial intelligence.

1 Introduction

The "Chemistry Curriculum Standards for General High Schools (2017 Edition, Revised in 2025)" clearly stipulates that chemistry teaching should be based on the fundamental task of fostering virtue and cultivating people, focus on the cultivation of core competencies, promote the deep integration of information technology and subject teaching, deeply explore the educational resources in Chinese excellent traditional culture, and create contextualized, exploratory, and thought-provoking chemistry classrooms. Organic chemistry is the core module of the high school chemistry knowledge system. "Ethanol" is the first hydrocarbon derivative that students come into contact with, and it is the introductory and foundational course of organic chemistry, playing an important role in connecting inorganic chemistry and organic chemistry, reshaping students' chemical cognitive thinking, and establishing an organic substance cognitive model. Traditional teaching mainly relies on summative evaluations and lacks real-time feedback on students' learning situations. As a result, it fails to form a complete teach-

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ing loop and lacks sufficient teaching precision. The teaching scenarios are mostly limited to basic daily life situations, lacking cultural connotations and educational extensions. There is a disconnection between knowledge teaching and value guidance.

Chinese classical literary works carry thousands of years of folk culture and life wisdom. A large number of life scenes and material changes recorded in them contain rich chemical knowledge, providing high-quality materials for chemical context teaching. The popularization of artificial intelligence technology empowers classroom teaching, enabling visualization of microscopic mechanisms, concreteization of thinking processes, and real-time evaluation of learning situations, effectively breaking through the bottlenecks of traditional teaching. Based on this, this paper integrates the traditional cultural context of "Dream of the Red Chamber" with AI digital technology to reconstruct the ethanol classroom teaching model, explores innovative teaching paths oriented towards student qualities, and helps students implement the core chemical qualities[1].

2 Teaching Philosophy and Design Basis

2.1 The Thinking-Based Classroom Teaching Concept

The thinking-based classroom focuses on activating students' deep thinking and constructing systematic cognition. It discards the cramming teaching model and adopts a complete process including stimulating interest through scenarios, driving with questions, conducting gradient exploration, and summarizing and elevating[2]. This approach guides students to actively explore and think independently. In the teaching of ethanol, this concept focuses on the enlightenment of students' organic thinking, breaks the inherent cognitive patterns of inorganic chemistry, helps students establish the core organic thinking model of "structure determines properties, and properties determine uses", and promotes students to progress from passive memorization of knowledge to active construction of thinking[3].

2.2 Contextual Education and Digital Teaching Concepts

Traditional cultural contexts can endow chemical knowledge with humanistic depth, enabling students to perceive the practicality of chemistry in literary scenarios and enhance cultural confidence in academic learning. AI digital teaching, through functions such as three-dimensional modeling, dynamic demonstrations, intelligent interaction, and data-based evaluation, makes abstract organic reaction mechanisms more intuitive, builds an efficient closed-loop classroom, and realizes the empowerment of technology to enhance teaching quality and efficiency[4].

2.3 The Core Idea of Macroscopic and Microscopic Combination

Macroscopic and microscopic combination is the core thinking method of the chemistry discipline, running through the entire process of high school chemistry teaching. This idea requires students to base on macroscopic experimental phenomena, deeply explore the microscopic structure and the essence of reactions, and then rely on the microscopic principles to explain macroscopic changes and guide practical applications. The key and difficult points of ethanol teaching lie in the correlation between structure and properties[5]. By applying the idea of macroscopic and microscopic combination, it can guide students to start from the macroscopic phenomena of ethanol, explore the microscopic mechanism of chemical bond breaking and recombination, precisely break through the teaching difficulties, and cultivate students' scientific chemical thinking methods.

3 Analysis of Existing Problems in Traditional Ethanol Teaching

3.1 Exploring the superficial Aspects, with Insufficient Thinking Training

The traditional classroom inquiry activity process is rigid, mostly consisting of mechanical verification experiments. Students do not need to independently design or reason through the inquiries, and their participation in thinking is extremely low. The classroom questions are mostly memory-based and shallow-level, lacking a gradient and logical inquiry problem chain. This makes it impossible to guide students to think deeply, resulting in students being unable to form a systematic organic chemistry thinking system, and the improvement of scientific inquiry and logical reasoning abilities is slow.

3.2 The Situation is Simple, but the Educational Value Is Lacking

Most ethanol teaching only adopts basic scenarios such as alcohol disinfection and daily drinking. The teaching materials are highly homogeneous, lacking cultural depth and educational connotations. The teaching overly focuses on knowledge transmission, neglecting the deep connections between chemistry and traditional culture, life health, and social life. It fails to permeate educational contents such as scientific attitudes, healthy concepts, and cultural confidence, resulting in a disconnection between subject teaching and the goal of cultivating moral character and promoting education.

3.3 Abstract Knowledge, Disconnection Between Macroscopic and Microscopic Cognition

Core knowledge points such as the catalytic oxidation of ethanol and its reaction with sodium involve the breaking and reformation of molecular chemical bonds. The microscopic changes cannot be directly observed. Traditional teaching relies solely on blackboard writing and static images for explanation, which is monotonous and abstract. Students find it difficult to understand the microscopic essence of the reactions, and there is a widespread problem of "knowing the result but not the reason", resulting in an inability to establish the correspondence between macroscopic phenomena and microscopic structures. The cultivation of the ability to integrate macroscopic and microscopic aspects is thus ineffective.

3.4 Delayed Evaluation, Broken Teaching Loop

Traditional teaching relies on end-of-lesson assignments, unit tests, etc. for evaluation, lacking dynamic evaluation during the classroom process. Teachers are unable to grasp in real time students' mastery of key and difficult points such as microstructures and reaction mechanisms, and it is difficult to precisely adjust the teaching pace. Students cannot promptly identify their own cognitive gaps, and the teaching loop of teaching, learning, evaluation, and correction cannot be formed, resulting in a significant reduction in the teaching's targetedness and effectiveness.

4 The Practical Application of Teaching Design that Integrates Traditional Culture with AI Technology

In response to the above issues, this teaching session takes the classic scene from "Dream of the Red Chamber" - "Xiangyun Drunkenly Lying on the Peony Cushion" as the core scenario. It links together four gradient-based teaching stages: "Exploring Alcohol - Getting Drunk - Overcoming Alcohol Intoxication - Using Alcohol", integrates AI digital technology, and constructs a new teaching model featuring immersive scenarios, progressive thinking, and closed-loop evaluation. This approach fully realizes the goals of cultivating core competencies.

4.1 Context Introduction: Engage with Classics, Create a Problem Scenario

In the classroom introduction part, by combining the original text segment of "Xiangyun's Drunkenness" from "Dream of the Red Chamber" and the film materials, we guide students to experience the charm of traditional wine culture. Regarding the setting of the problem of the gradient of the plot: "Why is Xiangyun prone to getting drunk? What changes occur to alcohol in the human body? What is the scientific principle of getting drunk? How to scientifically relieve alcohol intoxication in daily life?" With life-oriented and literaryized questions, we arouse students' interest in exploration, and naturally lead to the core research object of this class - ethanol. By using the context of the famous work to break the dullness of the chemistry class, we achieve the organic combination of cultural immersion and classroom introduction, and stimulate students' initiative in exploration.

4.2 Exploring Alcohol: AI Modeling, Investigating Microscopic Structure

To address the difficulty in understanding the abstract structure of ethanol, this lesson utilizes AI three-dimensional molecular modeling technology to dynamically display the molecular formula, structural formula and spatial structure of ethanol, visually presenting the connection methods of C, H, and O atoms, comparing the structural differences between ethanol and ethane, and water, helping students quickly grasp the structural characteristics of the hydroxyl functional group. Students can operate the AI model independently, rotate and split the molecule, visually observe the distribution of chemical bonds, independently deduce the structure of ethanol, and understand the core rule that "functional groups determine the properties of organic compounds".

4.3 Drunkenness: Experimental Investigation and Analysis of Reaction Principles

Based on the context of intoxication, the teaching focuses on exploring the core properties of ethanol catalytic oxidation. Students first independently complete the ethanol catalytic oxidation experiment, observing macroscopic phenomena such as the color change of copper wire and the alteration of odor, and initially deduce the reaction products. Regarding the microscopic processes of bond breaking and formation that are difficult for students to understand, AI dynamic animations are used to demonstrate the catalytic oxidation reaction mechanism step by step, clearly showing the process of breaking the hydroxyl bond and carbon-hydrogen bond, and intuitively presenting the generation process of acetaldehyde and water. Through the integration of "macroscopic experiments + microscopic animations", students can thoroughly understand the chemical essence of intoxication. Coupled with the gradient problem chain to drive students' deep thinking, the thinking progression from observing phenomena to exploring principles is achieved.

4.4 Alcohol Relief: Expanding and Integrating Health Concepts

Centered around the hot topics related to alcohol relief in daily life, relying on the AI human body metabolic flowchart, this course explains the oxidation and metabolism process of ethanol in the human body, clearly elaborating the complete path of ethanol converting into acetaldehyde and acetic acid, and ultimately decomposing into carbon dioxide and water. It scientifically explains the causes of intoxication and hangover. At the same time, it analyzes various folk misconceptions about alcohol relief through chemical knowledge, examines the scientific principles of alcohol relief methods such as fruits and honey water, and closely combines disciplinary knowledge with life health and real-life situations, integrating health living concepts and implementing scientific attitudes and social responsibility qualities.

4.5 Using alcohol: Connecting to Life and Realizing Application Value

This section is based on the core logic of "structure - properties - application", guiding students to combine the structure and properties of ethanol to independently summarize its applications in medical disinfection, food brewing, industrial solvents, clean energy, etc. By using AI to push forward examples of ethanol applications throughout history, it connects traditional brewing techniques with the development of modern alcohol industry, allowing students to intuitively experience the practical value and contemporary value of the chemical discipline, deepen their understanding of the core cognitive model, and enhance their subject application ability.

4.6 AI Enables Closed-Loop Evaluation and Promotes Cognitive Advancement

The entire teaching process is realized through the AI teaching platform for dynamic assessment. During the class, through forms such as intelligent questioning, model analysis, and in-class tests, the student's learning situation data is collected in real time, accurately identifying the students' knowledge weak points. Based on this, the teacher dynamically adjusts the teaching pace and conducts targeted explanations. After class, the platform pushes exercises based on the students' learning situations, achieving individualized teaching and generating learning situation analysis reports, providing data support for teaching optimization and constructing a complete teaching, learning, evaluation, and correction closed-loop system.

5 Teaching Practice Outcomes and Reflections

5.1 Teaching Practice Outcomes

This innovative teaching practice has achieved remarkable results. Firstly, the classic literature scenarios have effectively enriched the classroom content, stimulated students' interest in exploration, integrated cultural education with subject teaching, and enhanced students' cultural confidence. Secondly, the AI visualization technology has solved the teaching problem of abstracting microscopic knowledge, helping students quickly establish a combination of macro and micro thinking, and effectively breaking through the key and difficult points of teaching. Thirdly, the gradient teaching main line and problem-driven mode have promoted students' thinking to advance from shallow memory to deep exploration, effectively cultivating students' scientific thinking and inquiry ability. Finally, the AI closed-loop evaluation has achieved precise teaching and individualized teaching, significantly improving the efficiency of classroom teaching, and fully implementing the cultivation goals of core chemical literacy.

5.2 Teaching Reflection and Optimization Direction

There are still some deficiencies in the teaching practice. AI technology is mainly applied in the demonstration and evaluation stages, while students' practical application of AI tools for exploration and modeling is relatively rare. The students' dominant position has not been fully exerted. In the subsequent teaching, the AI teaching application scenarios will be optimized, and the student's independent exploration operation links will be increased; the hierarchical exploration task system will be improved to adapt to the learning needs of students at different levels, and the teaching model will be continuously optimized and innovated.

5.3 Analysis of Teaching Innovation Points

This "Ethanol" teaching design has achieved innovative breakthroughs in four dimensions compared to traditional organic chemistry classes: the educational model, technology application, thinking cultivation, and scenario creation.

Firstly, the innovative scenario-based educational model breaks through the limitations of homogeneous and life-oriented chemical teaching scenarios, deeply explores the scientific connotations and humanistic values of classic works, deeply integrates the classic literary scenes of "Dream of the Red Chamber" with the core knowledge of ethanol, making traditional culture no longer an embellishment of the classroom but a core thread running through the entire teaching process, achieving the two-way integration of scientific knowledge and humanistic culture, and fulfilling the fundamental educational goal of cultivating virtue.

Secondly, the innovative technology empowerment method differs from the simple image and video display of traditional multimedia. Relying on digital functions such as AI 3D modeling, dynamic reaction mechanism demonstration, and real-time learning situation analysis, it specifically addresses the teaching pain points of abstract microscopic knowledge in organic chemistry, visualizing unobservable chemical bond breaks, molecular structure changes, and human metabolism processes, allowing digital technology to truly serve the breakthrough of knowledge and the advancement of thinking.

Thirdly, the innovative thinking cultivation path constructs a gradient teaching mainline of "Exploring Alcohol - Getting Drunk - Solving Alcohol - Using Alcohol", which conforms to students' cognitive patterns, layer by layer promoting students from microscopic structure exploration, reaction principle analysis, to life application transfer, scientific concept construction, completely changing the shallow memory learning mode of traditional classrooms, systematically cultivating students' core chemical thinking of macro-micro combination, evidence reasoning, and model cognition.

Fourthly, the innovative teaching evaluation system abandons single final evaluation and builds a complete, dynamic, and precise teaching evaluation loop based on the AI platform, achieving real-time classroom detection, precise learning situation analysis, and differentiated post-class training, truly achieving individualized teaching and transforming teaching from "experience-based teaching" to "data-driven precise teaching". This innovative paradigm combines knowledge, interest, humanism, and technology, providing a new idea and feasible practical model for contextualized, digitalized, and thought-based teaching of the introductory organic chemistry course in high schools.

6 Conclusion

This article takes the teaching of "Ethanol" as the carrier, relying on the traditional cultural context of "Dream of the Red Chamber" and combining with AI digital technology, to construct a progressive teaching system of "Exploring Alcohol - Getting Drunk - Removing Alcohol - Using Alcohol", effectively solving problems such as the micro-abstraction of traditional teaching, insufficient exploration, shallow thinking, and disconnection in education. It helps students successfully construct the core cognitive model of organic chemistry, achieving the unity of knowledge transmission, ability cultivation, and value guidance. Classical masterpieces contain rich scientific education resources, and artificial intelligence provides a new path for classroom innovation. In future teaching, it is necessary to continuously promote the deep integration of traditional culture, digital technology, and the chemistry discipline, to create high-quality chemistry classrooms with a focus on qualities and progressive thinking, and provide strong support for the reform of high school chemistry teaching.

Author Contributions

Xue Liu conceived the idea of the study and wrote the paper. Hui Wang guided the revision of this paper.

References

1. Wang Ziyi. Research on Strategies and Practice of Integrating Excellent Traditional Chinese Culture into Senior High School Chemistry Teaching[D]. Inner Mongolia Minzu University, 2025. https://doi.org/10.27228/d.cnki.gnmmu.2025.000197
2. Pan Mengling. Research on Project-based Chemistry Teaching of "Chemistry + Guangxi Traditional Culture" Oriented by Core Literacy for Senior High School[D]. Southwest University, 2025. https://doi.org/10.27684/d.cnki.gxndx.2025.004223
3. Jia Tiantian, Zhang Zhongyan, Chen Xiaoge. Chemistry and Traditional Culture: Interpretation of Chemical Knowledge in the Classical Masterpiece A Dream of Red Mansions[J]. Journal of Chemical Education (Chinese & English), 2025, 46(23): 9-10. https://doi.org/10.13884/j.1003-3807hxjy.2025040029
4. Salgado M C ,Dam F D S R ,Salgado L W , et al.Prediction of chemical elements in cement using neutron activation analysis and artificial intelligence[J]. Radiation Physics and Chemistry, 2025,232112699-112699.https://doi.org/10.1016/J.RADPHYSCHEM.2025.112699.
5. Maxyn L ,Eric G ,Ning W , et al.Designing Game-Based Learning for High School Artificial Intelligence Education[J]. International Journal of Artificial Intelligence in Education, 2023,33(2):384-398.https://doi.org/10.1007/S40593-022-00327-W.