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Research on the Consistency of Teaching, Learning and Evaluation in Middle School Chemistry under the Orientation of Core Literacy

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Abstract

Under the Dual New context, the implementation of core competencies in chemistry subjects imposes new requirements for deep integration of teaching, learning, and assessment in classroom instruction. This paper systematically elucidates the theoretical connotations of the integration of teaching, learning, and assessment. Through literature review, it reveals issues such as fragmented goals, delayed evaluation, and superficial activities in current high school chemistry teaching. A practical framework is constructed that Goal Anchoring, Task Design, Context Construction and Dynamic Adjustment. An innovative teaching case on The Structure and Properties of Halogenated Hydrocarbons is designed, integrating the cultivation of core competencies such as Macroscopic Identification, Microscopic Analysis, Scientific Inquiry and Practice throughout the entire teaching process. Research shows that this model, through a spiral upward mechanism of goal-teaching-evaluation, effectively promotes the progressive development of students chemical thinking and enhances their problem-solving abilities, providing an operational practical paradigm for the transformation of classrooms oriented towards subject core competencies.

Keywords

Teaching, Learning, Assessment.

1. The Construction of The Subject Connotation of Teaching Learning and Evaluation Integration

The integration of teaching, learning and evaluation is a reconstruction of the education paradigm based on the essence of chemistry. Its core lies in using core competence as the link to transform teaching objectives, learning activities and evaluation system into an educational community with internal logic.

The Essence of Teaching: As guides of disciplinary thinking, teachers need to transform textbook content into inquiry tasks that align with students cognitive patterns through the pathways of knowledge problematization, problem contextualization and contextual thinking. For example, in teaching Halogenated Hydrocarbons, real world scenarios such as the ban and alternatives of Freon can be used to guide students in analyzing the chemical behavior of halogenated hydrocarbons from the perspective that structure determines properties, thereby establishing a cognitive model of functional groups, reaction mechanisms and application value.

The Essence of Learning: Students develop core competencies through the process of doing science, engaging in deep learning activities such as experimental inquiry, model construction, and evidence reasoning to transform from knowledge reception to mental construction. For example, in the experiment to test halogen atoms in halogenated hydrocarbons, students design comparative experiments to understand the scientific method of controlling experimental conditions.

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The Essence of Evaluation: Evaluation serves as the bridge between teaching and learning. Through a three-tier mechanism of formative assessment for immediate feedback-summative assessment for diagnostic attribution-developmental assessment for guiding orientation, it forms a closed loop from teaching objectives, learning evidence and evaluation standards. The evaluators include both teachers and students in mutual evaluations, self-evaluations by students, and peer evaluations. Evaluation methods encompass diverse formats such as lab reports, visualized thinking products, and problem-solving solutions.

The synergistic logic of the three is that: teaching objectives provide a yardstick for evaluation, learning activities provide evidence for evaluation, and evaluation results provide a basis for correction for teaching, which ultimately points to the integrated education goal of knowledge construction, thinking development and value recognition.

2. Implementation Framework of Teaching, Learning and Evaluation Integration in High School Chemistry

2.1. Three dimensional diagnosis: learning situation analysis and goal anchoring

2.1.1. Three dimensions of learning situation diagnosis

Cognitive basis diagnosis: Through pre-test questionnaire, concept mapping and other tools, accurately grasp the existing knowledge structure of students. For example, before learning Halogenated Hydrocarbons, test students understanding of derivatives of hydrocarbons and types of organic reactions, and identify the cognitive breakpoint of introduction and transformation of functional groups.

Diagnosis of thinking level: Using the evidence reasoning task such as giving the experimental phenomenon of halogenated hydrocarbon hydrolysis and requiring deducing the reaction mechanism, students are judged whether they have the ability to associate macroscopic phenomena with microscopic explanation and determine their zone of proximal development.

Cultivation of literacy development needs: Through interview method, students focus on chemistry and society such as environmental protection and materials science is understood, and the study of halogenated hydrocarbons is combined with the cultivation of scientific attitude and social responsibility literacy. The task of dialectical analysis of the advantages and disadvantages of halogenated hydrocarbons is designed.

2.1.2. Goal design oriented by literacy

2.2. Evaluation task: structured collection of multiple evidence

The three level evaluation system of classroom immediate evaluation, phased diagnosis and literacy development file is constructed to realize the real time interaction of teaching, learning and evaluation:

2.2.1. Design of classroom embedded evaluation tasks

Concept understanding: When explaining the elimination reaction, ask questions immediately: "What are the similarities and differences between the elimination products of 1-bromopropane and 2-bromopropane? Why?" Through students answers, diagnose the mastery of the concept of location selection.

Experimental inquiry: In the hydrolysis of halogenated hydrocarbons experiment, observe whether students can correctly choose reagents, record the experimental phenomena in a standard way, and conduct peer evaluation according to the Experimental Operation Evaluation Scale.

Visual thinking evaluation: Students are required to draw the transformation relationship diagram of halogenated hydrocarbons in organic synthesis, and teachers and students evaluate

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it from three dimensions: knowledge correlation, logical thinking and innovative application point.

2.2.2. Development of advanced evaluation criteria

Table 1. According to the curriculum standards, the teaching objectives are transformed into observable indicators of literacy performance (taking Halogenated Hydrocarbons as an example):

Core competency dimension	Specific teaching objectives	Evidence of performance
Macro identification and micro analysis	The mechanism of hydrolysis and elimination of halogenated hydrocarbons can be explained from the perspective of functional group (-X) and chemical bond (C-X polar bond).	Be able to write the reaction equation correctly and mark the position of bond breaking, and demonstrate the breaking and forming of chemical bonds in the reaction with stick model.
Evidence reasoning and model cognition	Establish a cognitive model of experimental phenomenon, reaction essence and general law, and summarize the regioselectivity of halogenated hydrocarbon reactions (such as Zayatsevs rule).	The experiment can be designed to verify the difference of elimination products of different halogenated hydrocarbons, and the experimental phenomenon can be explained by the model.
Scientific inquiry and practice	The halogen atom test scheme can be designed according to the principle of control variable, and the rationality and error source of the experimental scheme can be evaluated.	Submit the complete experimental report, including scheme design, phenomenon record, error analysis and improvement measures.
Scientific attitude and social responsibility	The application value and environmental risk of halogenated hydrocarbons are analyzed dialectically, and suggestions for reasonable use are put forward.	Complete the research report on the advantages and disadvantages of halogenated hydrocarbons, reflecting scientific ethics and social responsibility.

2.3. Deep construction: learning activity design in real situations

Following the path of deep learning context, problem, inquiry and transfer, teaching activities are designed with the main line that synthesis and application of halogenated hydrocarbons:

Context Introduction activate Cognitive Conflict. By presenting the contrast case between non-stick coating (polytetrafluoroethylene) synthesis route and CFCs depleting the ozone layer, teacher pose a driving question: "Why do some halogenated hydrocarbons benefit humanity while others harm the environment? What is the fundamental reason for these differences in properties?" Guide students to approach learning from the perspective of structure, property and application.

Model construction reveals the nature of reaction. Build the structure of chloroethane and bromoethane with the ball stick model, compare the polarity difference between C-Cl bond and C-Br bond, and understand the effection of bond polarity on reaction activity. The process of C-X bond breaking and OH^- attack in hydrolysis reaction was demonstrated by animation, and a

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microscopic cognitive model of polar bond breaking and nucleophilic substitution reaction was established.

Table 2. Take the literacy of "scientific inquiry and practice as an example, and design a four-level evaluation scale:

Level	Performance description	Teaching intervention suggestions
Level 4	Design innovative experimental scheme independently, control variables accurately, explain phenomena scientifically and put forward improvement strategies.	Provide extension research topics, such as the effect of different solvents on the reaction type of halogenated hydrocarbons, to support the development of higher order thinking.
Level 3	Under the guidance of teachers, the experiment design can be completed, and the phenomenon can be recorded and the conclusion can be derived, but there is a single loophole in the control of variables.	Design comparative experiments on loopholes, such as the effect of ethanol dosage on the rate of elimination reaction, to strengthen scientific method training.
Level 2	The experiment can only describe the surface phenomenon by imitating the steps of the textbook, but cannot establish the connection between the phenomenon and the essence.	The experimental task was divided into three steps: reagent selection, condition control and phenomenon recording.
Level 1	The experimental operation cannot be completed, the experimental principle and operation steps are confused, and the phenomenon is not related to the conclusion.	Provide visualized experimental micro-lessons to demonstrate the reaction mechanism through models and reconstruct the basic concept understanding.

Experimental Inquiry cultivating Empirical Thinking. Group completion of the Hydrolysis and Elimination Reaction of 1-Bromopropane control experiment, recording product differences under different conditions (solvent, temperature, catalyst). Verify the product structure through infrared spectroscopy analysis. Group discussion on how reaction conditions affect reaction types, forming a scientific understanding that condition control determines the reaction pathway.

Migration Application solving Real Problems. Industrial Contexts is created that the chemical wastewater contains chlorinated hydrocarbon pollutants, requiring a design to detect chlorine and prepare non-toxic substances. Students need to integrate knowledge such as hydrolysis reaction, acidification treatment and precipitation method detection to design a wastewater treatment process, explaining the chemical principles of each step, reflecting the competency orientation of using chemical knowledge to solve practical problems.

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2.4. Dynamic adjustment: implementation strategies of flexible teaching process

Build a three stages and six steps of dynamic teaching process to adapt to the generative needs of the classroom:

Diagnostic Introduction: Cognitive conflict caused by life cases, Independent pre-learning, Micro lesson learning, problem list marking confusion points

Cooperative inquiry: Group experiment to explore the mechanism of reaction, Deep dialogue, Teacher asks core questions such as "Why does ethanol need to be used as a solvent for elimination reaction?"

Generate expansion: Capture new questions raised by students such as "Can all halogenated hydrocarbons undergo elimination reaction?", and spontaneously generate a micro topic on structural conditions for elimination reaction.

Inductive modeling: Mind map to sort out the relationship network of Properties and applications of halogenated hydrocarbons, Layered evaluation, Basic questions reaction equation writing and extended questions complex synthesis route design

This process emphasizes the dialectical unity of pre-set and generation: teachers design the core problem chain and flexible plan in advance, and at the same time, they keenly capture the sparks of thinking generated by students in experiments and discussions such as suggestions for improving textbook experiments, and timely adjust the teaching pace, so as to transform classroom generation into a growth point of deep learning.

3. The Practical Effect and Reflection of The Integration of Teaching, Learning and Evaluation

Through a one term comparative experiment in a provincial model high school, it was found that the students in the experimental class were significantly better than those in the control class in terms of core competence:

Depth of thinking: In the organic synthesis inference question, students in the experimental class can write more than 3 transformation paths on average, and 60% of the answers reflect the functional group transformation strategy, while only 25% of the students in the control class can reach this level.

Inquiry ability: The number of experimental improvement plans proposed by students in the experimental class was 2.8 times that of the control class, and the variable control awareness and depth of error analysis in the plans were significantly improved.

Value recognition: In the discussion on the social impact of halogenated hydrocarbons, 82% of students in the experimental class were able to analyze the double edged sword effect of chemical substances dialectically, which was 27 percentage points higher than that of the control class (55%).

4. Conclusion

Research shows that the key success factors for integrating teaching, learning, and assessment lie in: ① the competency translation ability of in goal design ransforming abstract competency requirements into actionable learning tasks; ② the evidence capture ability of evaluation tools collecting student's thought processes through diverse media; ③ the dynamic scaffolding ability of teachers providing timely guidance at points of cognitive conflict. Future research can further explore the development of intelligent evaluation systems supported by AI technology to achieve precise profiling and personalized guidance for students core competency development.

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