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Innovation in Chemistry Culture Teaching Based on the "Four-Point Breakthrough" Paradigm: A Case Study of "Chemical Knowledge in Yi Embroidery"

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Abstract: With the deepening reform of basic education curricula, cultivating students' core competencies in chemistry teaching has become a hot topic in the field of education. This paper adopts the "Four-Point Breakthrough" teaching paradigm as its theoretical framework and integrates the intangible cultural heritage resources of Yi embroidery to explore new pathways for fostering core competencies in chemistry. By constructing a progressive teaching chain of "innate interest-accompanying interest-derivative interest," the study combines chemical knowledge with ethnic cultural resources, forming an ecological classroom model of "contextual stimulation-knowledge modeling-transfer and application." The results show that this teaching model effectively stimulates students' learning interest, enhances their scientific inquiry skills and cultural identity, and provides an innovative practical example for chemistry teaching in ethnic regions.

Keywords: Four-Point Breakthrough paradigm; Chemistry culture teaching; Yi embroidery; Core competencies; Scientific inquiry ability

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1. Introduction

1.1. Curriculum reform background and teaching challenges

The current reform of basic education curricula is oriented toward core competencies, aiming to implement the concept of "disciplinary education." However, the following contradictions persist in chemistry teaching practices.

First, there is a misalignment between curriculum concepts and learning motivation. Students' interest in chemistry often stems from the novelty of experimental phenomena, but it tends to decline as abstract concepts are introduced. In ethnic regions, students' limited awareness of the social application value of chemical knowledge, due to insufficient connections between textbook content and local culture, affects the sustainability of their learning motivation.

Second, the transformation of teaching methods faces structural resistance. Some classrooms still rely on one-way knowledge transmission, especially in areas with limited experimental resources. Teachers, constrained by objective conditions, struggle to implement inquiry-based teaching activities, which weakens the cultivation of students' scientific inquiry skills.

Third, the educational value of the discipline has not been fully realized. Current curricula inadequately explore the chemical wisdom embedded in traditional culture, making it difficult for students in ethnic regions to develop cultural identity during knowledge construction, thereby hindering the synergistic development of scientific spirit and humanistic literacy.

1.2. Proposal of the "Four-Point Breakthrough" teaching paradigm

To address these issues, Professor Zou Hongtao's research team at Qiannan Normal University for Nationalities proposed the "Four-Point Breakthrough" teaching paradigm. This paradigm emphasizes breakthroughs in interest points, starting points, key and difficult points, and goal achievement points, ensuring that interest permeates the entire classroom and constructing a complete teaching system. The paradigm highlights the functions of "stimulating interest, nurturing aspirations, and fostering habits" by activating innate interest, maintaining accompanying interest, and elevating derivative interest, thereby helping students develop lasting learning motivation and enthusiasm [1].

2. Core concepts

2.1. "Four-Point Breakthrough" teaching paradigm

The core of the "Four-Point Breakthrough" teaching paradigm is to "unlock" interest, emphasizing that interest is a fusion of cognition and emotion. It establishes strategies for activating innate interest through breakthroughs in starting points, maintaining accompanying interest through breakthroughs in key and difficult points, and elevating derivative interest through breakthroughs in goal achievement points (Table 1). This forms an endless chain of interest that runs through the entire teaching process, creating an ecological classroom where "interest arises as the lesson begins, deepens as it progresses, and lingers after it concludes" [2].

Table 1. "Four-Point Breakthrough" teaching paradigm

Four-point	Breakthrough
Key point of interest	By creating scenarios and employing problem-driven approaches, students' learning interest is stimulated, and their innate curiosity is activated
Starting point of teaching	Building upon students' prior knowledge and experiences, we design authentic, life-relevant instructional scenarios to facilitate meaningful connections between new and existing knowledge
Key and difficult knowledge points	Through experimental inquiry and problem-chain-driven approaches, we break through key teaching difficulties, enabling students to develop a profound understanding of core concepts
Target achievement point	Through knowledge transfer and extended application, we achieve teaching objectives while cultivating students' core competencies and comprehensive skills

2.2. "Chemical Knowledge in Yi Embroidery"

"Chemical Knowledge in Yi Embroidery" refers to the integration of chemical principles in Yi traditional embroidery with modern chemistry teaching, uncovering its scientific and cultural value. Specific aspects include:

Extraction of plant dyes and chemical reactions: involving redox reactions, pigment separation, and other chemical principles [3].

Chemical properties of embroidery threads: for example, the durability and corrosion resistance of hemp fibers [4].

Chemical aesthetics in pattern design: for example, the symmetry and stability of chemical structures, and the relationship between color combinations and chemical reactions [5].

Modern improvements to traditional techniques: for example, using modern chemical technology to enhance the environmental friendliness of dyes and preservation methods for embroidered works.

2.3. Progressive teaching chain of "innate interest-accompanying interest-derivative interest"

Innate interest: Students' natural curiosity about new things, stimulated through real-life contexts and cognitive conflicts [6].

Accompanying interest: Interest gradually formed during the learning process, maintained through activity-based teaching and problem chains.

Derivative interest: Transformed into deep-seated learning motivation and innovative thinking through knowledge transfer and extended applications.

3. Teaching design for "Chemical Knowledge in Yi Embroidery"

3.1. Analysis of teaching resources

Analysis of chemical elements in Yi embroidery culture: As an important part of Yi traditional culture, Yi embroidery contains rich chemical knowledge.

Extraction of plant dyes involves redox reactions. Students can explore color changes and chemical compositions of different plant dyes through experiments.

The selection of embroidery thread materials relates to fiber chemistry, such as the durability and corrosion resistance of hemp fibers. Students can compare the chemical properties of different fibers through experiments.

Symmetry in pattern design reflects the aesthetic value of chemical structures. Students can observe and analyze the symmetry of patterns to understand the stability and beauty of chemical structures [7].

Educational transformation of regional cultural resources: Yi embroidery resources provide vivid practical scenarios for chemistry teaching. By transforming the chemical principles of intangible cultural heritage into educational content, students can understand the practical application of chemical knowledge in real contexts, enhancing the fun and meaningfulness of learning. For example:

Dye extraction experiments: Students can extract plant dyes by hand to understand the principles of redox reactions [8].

Comparative experiments on eco-friendly dyes: By comparing natural plant dyes with modern chemical dyes, students can explore the relationship between chemical technology and environmental protection.

3.2. Setting teaching objectives

Knowledge and skills: Students can identify chemical substances and their properties in Yi embroidery production, and understand chemical principles in traditional techniques (e.g., dye extraction and preservation, fiber durability).

Process and methods: Through contextual teaching and experimental inquiry, students can connect chemical knowledge with life practices and use observation, reasoning, and modeling to analyze scientific phenomena in an ethnic culture.

Emotional attitudes and values: It aims to cultivate students' sense of identity and pride in ethnic culture, help them appreciate the aesthetic value of the integration of science and humanities, and strengthen cultural confidence [9].

3.3. Teaching case design

Case 1: Extraction of plant dyes and redox reactions [10], as presented in **Table 2**.

Table 2. Case 1

Situational lead-in	Students visit the Yi embroidery street, where they can observe the material differences between traditional fabrics and modern cotton textiles. Pose the driving question: "Why can traditional hemp fabric remain intact for centuries without decaying?" This real-world scenario effectively sparks students' curiosity and desire for inquiry
Knowledge modeling	Experimental design: Students work in groups to extract natural dyes from plants, specifically using indigo plants to produce blue dye. Experimental procedure: 1. Crush the leaves of the indigo plant and mix them with an appropriate amount of water and lime (as an alkaline catalyst). 2. After allowing the mixture to sit for a period of time, filter it to obtain the blue dye solution. 3. Soak white cotton fabric in the dye solution and observe the color change.
Principle explanation	Through experimental observations, the teacher explains the principles of redox reactions, illustrating the reduction process of indigo dye under alkaline conditions
Transfer application	1. Environmental comparison: Compare the eco-friendliness of natural plant dyes versus modern synthetic dyes, examining how chemical technologies can be applied for environmental protection. 2. Extension task: Design an eco-friendly textile dyeing product. Students are required to integrate experimental findings, propose innovative solutions to enhance the environmental sustainability of traditional dyeing methods

Case 2: Chemical properties of embroidery threads, as presented in **Table 3**.

Table 3. Case 2

Situational lead-in	Display embroidery threads of different materials (e.g., linen fiber, cotton fiber, silk fiber), and pose the question: "Why is linen fiber predominantly chosen for Yi embroidery?" Through tactile observation and visual comparison, stimulate students' curiosity
Knowledge modeling	1. Experimental design: Students work in groups to conduct durability tests on different embroidery thread materials. 2. Experimental procedure: Take segments of linen fiber, cotton fiber, and silk fiber, and measure their initial length. Soak the segments separately in: Acidic solution (e.g., acetic acid) Alkaline solution (e.g., sodium carbonate solution) Neutral solution (control group) for 24 hours. Remove the threads, measure their length changes, and observe fiber breakage conditions.
Principle explanation	Based on experimental data, the teacher explains the chemical stability of different fibers under acidic and alkaline conditions, demonstrating linen fiber's superior durability and corrosion resistance
Transfer application	1. Practical application: Explore how modern chemical technologies can be utilized to enhance embroidery thread materials, improving their durability and colorfastness. 2. Extension task: Design a contemporary embroidery product that incorporates Yi ethnic motifs. Students are required to: Draw upon experimental findings Propose innovative solutions to optimize thread material performance

Case 3: Chemical aesthetics in pattern design, as presented in **Table 4**.

Table 4. Case 3

Situational lead-in	Display traditional patterns from Yi embroidery and pose the question: "Why do these patterns appear so symmetrical and aesthetically pleasing?" Through observation and discussion, stimulate students' curiosity and engagement
Knowledge modeling	Observation & analysis: Students work in groups to examine the symmetry and color composition of Yi embroidery patterns, documenting their findings
Principle explanation	Teacher's explanation: The instructor explains the relationship between chemical structure symmetry and molecular stability, while connecting these principles to color theory in design (e.g., how complementary colors create visual contrast due to their underlying chemical properties).
Transfer application	Design task: Students are required to work in groups to design a modern pattern that integrates Yi embroidery elements, with the requirement to reflect the principles of chemical aesthetics. Presentation and evaluation: Each group will present their design outcomes, and both teachers and students will jointly evaluate their scientific validity and aesthetic appeal.

4. Implementation path of the "Four-Point Breakthrough" teaching paradigm

4.1. Activating innate interest: Contextual introduction strategies

Creating real-life contexts [11]:

Students visit Yi embroidery streets, observe the material differences between traditional and modern cotton fabrics, and pose driving questions such as, "Why can traditional hemp cloth remain intact for centuries?" This stimulates students' curiosity and desire to explore.

Stimulating cognitive conflicts:

Presenting comparative experiments between modern chemical dyes and natural plant dyes, asking, "Which dyeing method is more environmentally friendly?" Use cognitive conflicts to prompt deep reflection on the application of chemical knowledge.

4.2. Maintaining accompanying interest: Knowledge modeling process

Activity-based teaching strategies:

Designing a "dye extraction" experiment to explore the chemical composition of plant dyes. Through hands-on operations, students observe color changes and understand the principles of redox reactions [12].

Problem-chain-driven strategies:

Using "hearth culture" as a starting point to construct a problem chain: "How does fire change the color of ores? → What is the principle of oxidation reactions? → How are Yi embroidery pigments preserved?" Guide students to delve deeper into inquiry through interconnected questions.

4.3. Elevating derivative interest: Transfer and application design

Knowledge transfer strategies:

Guiding students to apply chemical anti-moth principles to design preservation solutions for Yi embroidery, exploring how modern chemical technology can improve traditional embroidery techniques.

Extended learning design:

Assigning project-based tasks, such as "Design an eco-friendly dyeing and weaving product incorporating Yi embroidery elements," encouraging students to combine chemical knowledge with cultural creativity to foster innovative thinking and practical skills.

5. Teaching effects and reflection

5.1. Analysis of student learning performance

Observation of interest sustainability:

Through quantitative analysis of classroom participation and tracking of post-class extended learning behaviors, it was found that students' participation in contextual teaching significantly increased, and their independent inquiry behaviors after class noticeably rose. This indicates that the "Four-Point Breakthrough" paradigm effectively sustains students' learning interest [12].

Assessment of core competency development:

Students showed significant improvement in scientific inquiry skills, cultural understanding, and value identification. For example, they demonstrated strong scientific thinking in experimental design and data analysis, and exhibited profound cultural identity when discussing the cultural value of Yi embroidery.

5.2. Discussion on the applicability of the teaching paradigm

Educational transformation efficiency of ethnic cultural resources:

Yi embroidery resources provide abundant materials for chemistry teaching. Through contextualized, problem-based, and project-based teaching designs, deep educational transformation of cultural resources is achieved [13].

Potential for cross-disciplinary application of the “Four-Point Breakthrough” paradigm:

The paradigm emphasizes the activation, maintenance, and elevation of interest, demonstrating strong universality. By adjusting contextual creation and problem design, it can be applied to teaching practices in other disciplines such as physics and biology.

6. Conclusion and outlook

6.1. Summarizing the innovative value of “Yi Embroidery Chemistry” teaching practice

This study integrates Yi embroidery cultural resources with chemistry teaching through the “Four-Point Breakthrough” teaching paradigm, constructing an ecological classroom model of “contextual stimulation-knowledge modeling-transfer and application.” It effectively enhances students’ learning interest and core competencies.

6.2. Proposing recommendations for promoting the “Four-Point Breakthrough” paradigm in ethnic regions

It is recommended that schools in ethnic regions systematically organize local cultural resources, develop teaching cases that integrate disciplinary knowledge, and promote the “Four-Point Breakthrough” paradigm through teacher training and teaching seminars to improve regional teaching quality [14].

6.3. Future directions for research on the integration of science and humanities in education

Future research could further explore educational models that integrate science and humanities, develop more interdisciplinary teaching resources, and provide theoretical support and practical guidance for cultivating well-rounded talents.

Disclosure statement

The author declares no conflict of interest.

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