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A Systematic Approach to Transforming the Teaching Model of "Coffee Tasting and Preparation"

From Skills Training to Decision-Making Skills Development

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ABSTRACT

As a practical course that integrates sensory art and scientific principles, the teaching objective of "Coffee Tasting and Preparation" should not be limited to skill imparting, but should also focus on cultivating students' scientific thinking and independent decision-making abilities. A teaching reform system based on "inquiry-based learning" as the core, "data sensory integration" as the support, and "three-stage progressive experimental chain" as the implementation path has been constructed to address the deep-seated problems of "disconnection between data and perception", "teacher feedback replacing student judgment", and "difficulty in knowledge transfer" in current teaching. The course systematically guides students from "step-by-step operation" to "independent analysis, judgment, and adjustment" by reconstructing teaching content, innovating teaching methods, and reforming evaluation mechanisms, achieving a role transformation from "learners" to "researchers". Practice has shown that this reform effectively enhances students' scientific exploration ability, systematic thinking, and innovative confidence, providing a reference paradigm for similar practical course teaching.

Keywords: *"Coffee Tasting and Preparation", Reform in education, Inquiry-based learning, Data as the drive, Sensory science, Advanced abilities.*

1. INTRODUCTION: THE INEVITABLE SHIFT IN COURSE POSITIONING AND TEACHING REFORM

Coffee, as a global beverage, contains a complex knowledge system from agricultural cultivation, processing, baking science to extraction techniques, sensory tasting, and market culture. The teaching objective of the course "Coffee Tasting and Preparation" has always been not only to teach students how to brew a cup of coffee with a decent taste, but also to guide them to understand and master this complex system. However, in long-term teaching practice, a fundamental contradiction has become increasingly prominent: students are able to proficiently imitate operational processes, but find it difficult to independently analyze problems and make effective decisions in real and changing situations. This contradiction points to the limitations of the traditional skill teaching model - it fails to place students at the center of cognitive construction and fails to stimulate their exploratory drive as learning subjects.

This limitation is not due to insufficient teaching investment, but is rooted in the logical starting point of curriculum design. If teaching only ends with "mastering the correct steps" and "replicating standard flavors", then the abilities developed by students will inevitably be fragile and context dependent. True professional competence is reflected in the systematic thinking ability to analyze, hypothesize, verify, and optimize based on principles when facing real challenges such as unfamiliar bean seeds, unstable water quality, and sudden equipment variables. Therefore, the fundamental task of this curriculum reform is to promote a profound transformation of teaching

philosophy from "imparting imitation" to "exploring construction", and to build a new learning ecology that is student-centered, driven by real problems, and centered on scientific thinking.

2. CORE PROBLEM ANALYSIS: THE ABILITY DILEMMA BEYOND THE SUPERFICIAL SKILLS

Reform begins with a profound analysis of the real teaching difficulties. Through long-term observation and reflection, it has been found that the bottlenecks in students' ability development are mainly reflected in three interrelated levels, which together constitute the core problem areas that teaching reform needs to face.

2.1 Cognitive Disconnect Between Quantitative Data and Sensory Experience

The introduction of tools such as concentration meters (TDS) in the course aims to provide objective feedback, but in practice, data is often simplified by students as a "ruler" of right and wrong. They focus on whether TDS falls within the golden cup range, but rarely ask about the reasons behind the data: what kind of interaction between grinding degree, water temperature, and time leads to the current extraction rate? What sensory features does this data correspond to? If you want to enhance acidity or sweetness, which parameter should be adjusted first and what is the theoretical basis? The tool has failed to become a "thinking bridge" connecting operational variables and flavor results, and may instead become a new "memory burden". This disconnect leads students to still rely on intuition or external instructions when adjusting, and scientific instruments have not been internalized as their way of thinking for analyzing problems.

2.2 The Implicit Dissolution of Autonomous Judgment Ability by External Feedback

During the teaching process, professional and timely individual guidance from teachers is a valuable resource, but it inadvertently triggers a dependency mentality. Students tend to view teachers' comments as "authoritative answers", and their learning cycle simplifies from a complete "design execute feel analyze adjust verify" to "operate wait for evaluation receive instructions". Their focus shift from “What does this cup of coffee reflect?” to “Where did the teacher think I was wrong”. Once this mentality is solidified, students may easily fall into the dilemma of being afraid to make decisions and unwilling to take responsibility in post class exercises or future work scenarios without immediate guidance, because the "muscles" of independent judgment have not been fully exercised.

2.3 Transfer Failure of Solidified Knowledge in Dynamic Contexts

Students often find the "best solution" for a fixed bean through repeated practice and regard it as the "universal formula". This reflects its insufficient understanding of coffee as an "active system". The flavor potential of coffee beans is influenced by multiple variables such as origin, processing method, roasting curve, storage status, and even daily temperature and humidity. When faced with new beans or new environments, students often do not "listen" to beans with curiosity, but mechanically apply old plans and become confused after encountering setbacks. What it fundamentally lacks is a flexible problem-solving framework: how to form initial hypotheses based on the basic information of beans, design concise experiments to verify key variables, and iteratively adjust based on evidence. The ability to independently define problems, learn quickly, and adapt in complex and open contexts is precisely the high-level literacy that the curriculum needs to focus on cultivating.

The above issues collectively reveal a deep contradiction: although the curriculum provides principles and tools, it fails to create a real learning environment that forces students to think like researchers and make decisions like product developers. Students' cognition is limited to "verifying the known" and difficult to leap to "exploring the unknown".

3. REFORM CONCEPT AND OVERALL ARCHITECTURE: BUILDING AN "INQUIRY-BASED LEARNING" ECOSYSTEM

In response to the core contradictions mentioned above, the curriculum reform has established a clear concept: student-centered, starting from real and complex brewing problems, taking scientific exploration as the main line, guiding students through a structured support system to experience a complete process of

knowledge construction and ability generation, and ultimately internalizing it into transferable higher-order thinking and action confidence.

To achieve this concept, the course has constructed a comprehensive experimental teaching system called "three stages, four dimensions, dual drive", which has the following connotations:

The "three stages" refer to the hierarchical path of ability development: cognitive calibration → variable control exploration → comprehensive transfer application. Three stages progress, interlocking to ensure steady improvement of students' abilities.

The "four dimensions" refer to the dimensions of literacy that integrate teaching objectives: scientific thinking, sensory ability, technical operation, and humanistic aesthetics. Four dimensions run through all teaching processes, pursuing the comprehensive development of students.

“Dual drive” refers to the two major engines that drive the deepening of learning: data-driven and AI-assisted decision-making. Both are not flashy tools, but rather deeply integrated into the exploration process as "cognitive partners", transforming abstract principles into real-time, interactive, and visual learning scaffolds.

The core logic of this system is to establish a knowledge foundation by reconstructing content modules, create exploration scenarios through a three-level experimental chain, provide instant feedback and thinking support through a "dual drive" tool, and ultimately guide learning direction through process evaluation, jointly forming a complete ecosystem that inspires, supports, and verifies students' independent learning.

4. RECONSTRUCTION OF TEACHING CONTENT: A KNOWLEDGE GRAPH FROM FRAGMENTS TO SYSTEMS

To achieve inquiry-based learning, the first step is to integrate complex industry knowledge into a logically coherent and exploratory system. The course content is refactored into four major modules, forming a clear sequence from cognitive origins to innovative applications.

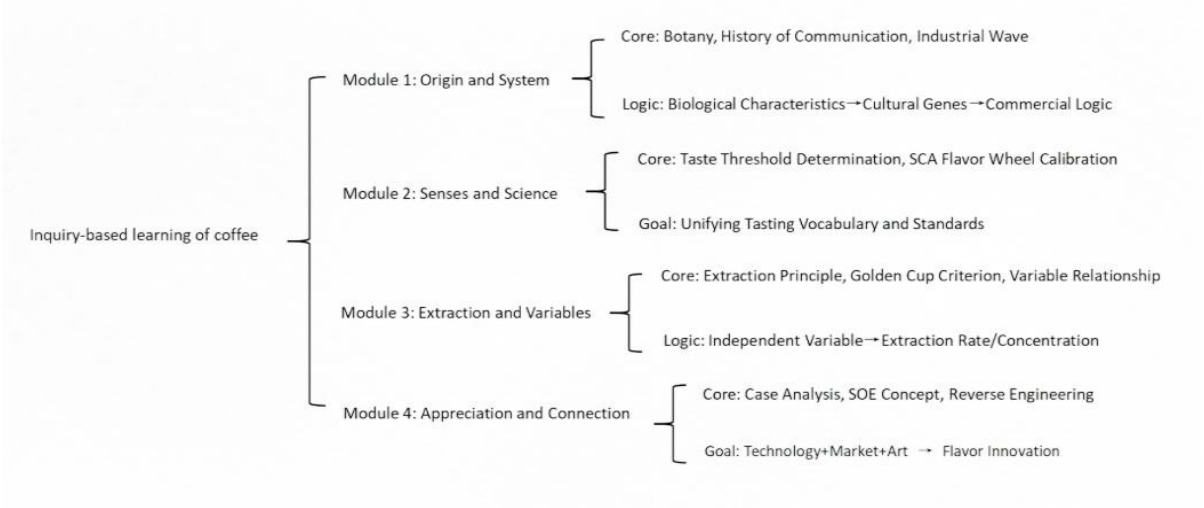

Figure 1 Course content modules.

4.1 Module 1: Origin and System - Building a Macro Cognitive Framework

This module integrates coffee botany, global dissemination history, and industry evolution. Not only does it explain the variety differences between Arabica and Robusta, but it also guides students to think about how biological characteristics affect flavor potential; Not only does it outline the historical journey of coffee, but it also explores how cultural migration shapes consumer habits; Not only does it introduce the three waves, but it also analyzes the interactive relationship between business evolution and technological innovation. The goal is to help students establish a macro perspective of "biological characteristics cultural genes business logic" and understand the profound system behind the flavors in the cup.

4.2 Module 2: Senses and Science - Establishing an Objective Descriptive Language

Sensory tasting is the core of coffee, but also the most subjective. In this module, the foundation of sensory science is introduced, upgrading the traditional "cup test" to a rigorous "sensory measurement experiment". By measuring the basic taste threshold, students' senses are calibrated using standard solutions of citric acid, quinine, sodium chloride, and sucrose; Through the "SCA flavor wheel description calibration training", coffee samples with typical flavor orientations (such as citrus flavored Yegashifel and nutty chocolate flavored Mantenin) are used to unify tasting vocabulary and intensity scales. This module aims to eliminate subjective ambiguity in communication and establish a common language for subsequent flavor based scientific discussions.

4.3 Module 3: Extraction and Variables - Mastering Core Scientific Models

This is the core of physics and chemistry in the course. By systematically teaching the extraction principle, the "Golden Cup Rule" (extraction rate 18% -22%, concentration 1.15% -1.35%) is transformed from an abstract chart into an understandable scientific model: coffee powder is the solute source, water is the solvent and carrier, and the powder water ratio, time, temperature, grinding degree, and stirring method are variables that control the dissolution rate and degree. The focus is on revealing the dynamic relationship between the two core dependent variables of "extraction rate" and "concentration" and all operational independent variables, providing a solid theoretical framework for students to independently design experiments and interpret data.

4.4 Module 4: Appreciation and Connection - Cultivating Product Thinking and Innovation Awareness

Teaching ultimately needs to be directed towards application and creation. In this module, the teachers will deeply analyze classic commercial product cases (such as Luckin Coffee's popular logic) and the SOE (Single Origin Espresso) concept of specialty coffee. Teachers can guide students to reverse engineer and analyze the intrinsic connection between flavor design, technological implementation, and market positioning behind a successful product. They can encourage students to think: How to design a brewing plan for a specific Ethiopian washed bean to highlight its floral and fruity aroma? How can it be transformed into a popular creative beverage among the public? Thus, technological learning is linked with market insights and artistic expression.

5. INNOVATION OF TEACHING METHODS: THREE STAGE PROGRESSIVE EXPERIMENTAL PROJECT CHAIN

The core carrier of teaching is a carefully designed chain of experimental projects. The three-stage design ensures the asymptotic nature of the learning path and the suitability of the challenges.

5.1 Stage 1: Basic Cognition and Sensory Calibration Experiment

Objective: it is to establish an objective "measurement scale" and unify the "language" of tasting.

Content:

- 1. Basic taste threshold measurement experiment: In the laboratory environment, students taste different concentrations of standard taste solutions in sequence, identify and record their perception thresholds, and understand individual sensory differences.
- 2. Flavor wheel description calibration workshop: Under the guidance of teachers, students conduct collective tasting of coffee samples with typical flavors, practice using standardized vocabulary to describe dry aroma, wet aroma, flavor, acidity, alcohol thickness, aftertaste, etc., and score the intensity to reach a consensus on description.

Meaning: This stage eliminates the ambiguity of sensory evaluation, allowing students to establish all subsequent flavor discussions on a relatively objective basis.

5.2 Stage 2: Variable Control and Principle Exploration Experiment ("Data - AI" Dual Drive Core Scenario)

Objective: it is to experience the complete scientific exploration cycle of "hypothesis testing analysis optimization" and establish causal logic between variables and results.

Traditional dilemma: After adjusting for a single variable, students can only make vague judgments based on their final taste, and the interaction between multiple variables is chaotic and unclear, resulting in low learning efficiency.

Innovation process:

- 1. Task initiation and scheme design: The group receives the same coffee bean and a clear task (such as "pursuing a balance of sweetness and sourness"). Firstly, based on the knowledge of Module 3, a collective discussion is held to form an initial boiling plan (determining the amount of powder, water, water temperature, grinding degree, water injection strategy, etc.), and the design ideas are recorded.
- 2. Precise execution and data collection: Brew according to the plan. After completion, the first step is to use a TDS concentration meter to accurately measure the concentration of coffee and record all actual operating parameters (including total extraction time, etc.).
- 3. AI intelligent real-time analysis and feedback: people input TDS data, powder water ratio and other information into the coffee extraction auxiliary analysis platform. The platform has a built-in rule library based on the "Golden Cup Rule" and extraction principle, which can perform logical reasoning and generate structured feedback reports.
- 4. Evidence based discussion and decision-making: Students conduct group discussions based on feedback from the AI platform, theoretical knowledge, and actual taste experiences (whether sharp or weak). The platform provides "suggestion ideas" based on common logic, rather than "operational instructions". Students must understand the principles behind each suggestion and may integrate them to generate their own optimization solutions (such as deciding to slightly increase the water temperature to 90℃ while refining and grinding).
- 5. Iterative validation and cognitive closure: Students execute the new plan, measure the data again, and submit it. The platform automatically generates a comparison chart of new and old data. Students taste the second cup of coffee and directly experience the sensory changes brought about by data improvement (such as an increase in extraction rate to 18.5%) (the sharp acidity becomes softer, and the sweetness and richness are revealed). At this point, the complete chain of "changes in physical parameters → changes in extraction kinetics → differences in soluble substance precipitation → presentation of sensory flavor" has been personally verified and deeply understood by students.

5.3 Stage 3: Comprehensive Exploration and Deep Cognitive Experiments (Classroom Micro Research)

Objective: it is to complete a complete micro exploration cycle of "controlling variables - comparative observation - analysis attribution" within a tight class period, and to cultivate preliminary research abilities.

Implementation form: "Theme Comparison and Exploration Workshop". Students will complete a focused comparative experiment in groups within 2-3 class hours and present an analysis report. The example is as follows:

- Topic A: Comparison of the Effects of Baking Degree on Extraction Behavior. The group will receive both a deep roasted blended bean and a light roasted Yajia Xuefei at the same time. Task: it is to find a brewing solution for two beans that achieves a "relatively balanced taste" (with the assistance of an AI platform). Core requirement: it requires to record and compare significant differences in grinding degree, water temperature, and/or time between the two to achieve similar concentrations or acceptable flavors. The goal is to empirically and intuitively understand how roasting degree profoundly changes the "extractability" material structure of coffee beans.
- Topic B: Exploration of the Boundary of Boiling Water Temperature. Using the same bean and strictly controlling other variables, students boil it three times with water temperatures of 85 ℃, 90 ℃, and 94 ℃ respectively. They measure and compare TDS and extraction rate data, and combine with tasting to systematically describe the changing trends of acidity, sweetness, bitterness, and alcohol thickness with increasing water temperature. The goal is to quantify the specific effect of water temperature, a key variable, on extraction efficiency and flavor direction.

This stage emphasizes the complete exploration process: raising questions → designing experiments → executing and recording → data analysis →

drawing conclusions → reporting and communicating. It goes beyond making a good cup of coffee and points towards more general scientific thinking training.

6. REFORM OF TEACHING EVALUATION: MULTI-DIMENSIONAL EVALUATION OF PROCESS AND ABILITY

To match inquiry-based learning, the evaluation system must shift from a "result-oriented" to a "process and ability oriented" approach. The course has established a "three-dimensional integrated" comprehensive evaluation system:

Process data and research report (40%): this part focuses on evaluating students' performance in the second and third stage experiments. Including: completeness and standardization of experimental parameter records; Understanding and application logic of feedback from AI platforms; Rationality of optimization scheme design; Does the experimental report clearly demonstrate the complete thinking chain of "problem data analysis decision verification reflection".

Practical norms and collaborative effectiveness (30%): Teachers evaluate students' instrument operation norms, rigorous process execution, safety and hygiene awareness, as well as their communication and collaboration, division of labor and cooperation, and collective decision-making effectiveness in group exploration through classroom observation.

Knowledge application and exploration results (30%): this part takes the results report of the third stage "Theme Comparison and Exploration Workshop" as the core basis. Through the oral report and written summary of the group, teachers comprehensively evaluate students' knowledge integration ability, depth of comparative analysis, rigor of logical reasoning, and clarity of expression and communication.

7. REFORM ACHIEVEMENTS AND CHARACTERISTICS: FROM BEHAVIORAL CHANGES TO CULTURAL RESHAPING

After multiple rounds of teaching practice, the reform has achieved significant and far-reaching results:

7.1 Fundamental Transformation of Students' Thinking and Behavioral Patterns

From "waiting for answers" to "actively solving": Faced with unsatisfactory extraction results, students' first reaction shifts from "looking for teachers" to "checking data, reading reports, and discussing in groups", forming a thinking habit of "design first, measurement accompanying, data speaking, and optimizing evidence-based".

From "fuzzy estimation" to "precise regulation": Students' understanding of key variables has reached a quantitative level. For example, it can be clarified that 'in order to increase the thickness of alcohol, I plan to grind and refine half a grid, and the extraction time is expected to be extended by 15 seconds. The goal is to increase the extraction rate from 19% to 20%'.

Preliminary cultivation of exploration ability: Through the third stage workshop, students are able to quickly design and execute simple comparative experiments, and can combine data and senses to conduct logical comparative analysis and attribution, possessing preliminary scientific research thinking.

7.2 Deep Internalization of Core Course Objectives

The “Golden Cup Rule” has transformed from a theoretical chart that requires memorization to an experimental 'target interval' and an adjusted “navigator”.

Complex sensory descriptors (such as "bright citrus acidity" and "sucrose like sweetness") have established a strong psychological relationship with specific TDS and extraction rate data, achieving a true "unity of knowledge and action".

7.3 Classroom Ecology and Reconstruction of Teacher-Student Roles

The role of a teacher has successfully transformed from being a "technical authority" and "final judge" to being an "experimental designer", "exploration coach", and "thinking catalyst". The core of classroom discussions focuses on data interpretation, scheme argumentation, and flavor exploration.

Classroom culture is evolving towards a "learning community". The communication

between students and between teachers and students is based on equal dialogue of evidence and logic, which greatly stimulates subjectivity, collaboration, and inquiry.

The distinctive features of this course reform are:

“Data - AI” as a deep cognitive tool: technology is not just superficial information embellishments, but deeply integrates and reconstructs the exploration process, becoming a "scaffold” that supports students' autonomous construction of knowledge.

The organic balance between scientificity and artistry: Reform always adheres to the principle of "data serving flavor". The teaching process adheres to the principle of "objective analysis first, subjective experience later", ensuring that scientific tools ultimately lead to a deeper understanding and appreciation of coffee flavor art, rather than replacing it.

The results have broad transferability value: the core competencies of "quantitative experimental thinking, variable control methods, and data-driven decision-making" honed can be transferred to food science, sensory evaluation, product development, and even broader engineering and experimental disciplines, with universal significance.

8. REFLECTION AND FUTURE PROSPECTS

In the practice of teaching reform, the researchers continuously engage in dynamic reflection and adjustment:

- Regarding the positioning of technical tools: The researchers have always been clear that AI analysis platforms are powerful "auxiliary tools" whose fundamental value lies in concretizing abstract principles and providing real-time feedback, thereby freeing up teachers' energy, achieving more personalized guidance, and expanding the depth and breadth of exploration. It cannot and should not replace the indispensable emotional and intelligent teacher-student interaction and thinking collision in teaching.
- The depth and breadth of exploration: How to ensure the mastery of basic skills while providing sufficient open space for exploration within a limited number of class hours is an eternal balance proposition. The researchers attempt to maximize the effectiveness of exploration under constraints by carefully designing the third stage of 'classroom micro research'.

Looking towards the future, curriculum reform will continue to deepen:

- Continuous evolution of platforms and resources: The researchers plan to further develop and optimize the "Coffee Extraction Auxiliary Analysis Platform", enrich its rule base, and explore the integration of simple machine learning models to provide students with more personalized trend predictions based on historical data.
- Innovation connection between in class and out of class: it is necessary to establish incentive mechanisms to encourage the extension of excellent ideas or unsolved problems that emerge from the third stage classroom exploration to extracurricular interest groups, innovation and entrepreneurship projects, or university competitions (such as brand planning competitions, coffee brewing competitions), making course teaching the starting point for students' sustainable innovation practices.
- Expansion of Teaching Community: By holding open teaching courses and workshops, sharing reform experiences, and collaborating with relevant course teachers from sister universities to build a practical teaching community, the researchers promote the iteration and promotion of reform concepts and models.

9. CONCLUSION

The teaching reform of the course "Coffee Tasting and Preparation" is a systematic reconstruction from teaching philosophy, content system, method path to evaluation culture. Its fundamental purpose is to cultivate students' higher-order thinking and action abilities to cope with complex worlds. By constructing a "three-level four-dimensional dual driven" inquiry-based learning ecosystem, it successfully guides students to grow from passive "operators" to active "researchers" and "decision-makers". This practice demonstrates that even skill-based courses that heavily rely on sensory experience can achieve a deep integration of knowledge transmission and skill development through scientific and student-centered design. The value of reform lies not only in brewing a better cup of coffee, but also in

empowering students with a portable scientific spirit, systematic thinking, and innovative confidence when facing various uncertainties in the future. This is precisely the profound meaning that higher education teaching innovation should pursue.

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