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Research on the Design of Question Chains Based on SOLO Taxonomy: Taking 'Factors of Agricultural Location' as an Example

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ABSTRACT
Taking "Agricultural Location Factors" as an example, this paper designs a question chain based on the SOLO Taxonomy Theory. First, it outlines the five levels of the SOLO Taxonomy Theory. Then, it analyzes the teaching content of "Agricultural Location Factors" and determines the teaching objectives. By using the example of "Gaozhou Lychees", a question chain is constructed, starting from the unistructural level, progressing to the relational level, and finally reaching the extended abstract level, to guide students to conduct in - depth exploration step by step. The aim is to enhance students' core geographical competencies and provide an innovative example for geography teaching.

KEYWORDS
SOLO taxonomy theory; Question chain; Agricultural location; Geography teaching

1 Introduction

With the advancement of educational reform, cultivating students' core geographical competencies has become an important goal of geography teaching. The SOLO taxonomy theory offers a new perspective for teaching evaluation and design, effectively guiding students to progress from lower-order thinking to higher-order thinking. In high school geography teaching, the factors of agricultural location are highly comprehensive. Nevertheless, traditional high school geography teaching often confines itself to textbook knowledge. As a result, students usually have a shallow understanding of these factors and lack practical application skills. Designing a question chain using "Gaozhou lychees" as an example helps integrate geographical theories with agricultural practices and enhance students' cognitive and analytical abilities for regional agricultural development.

2 Overview of the SOLO classification theory

The SOLO theory is a classification and evaluation theory put forward by Professor John Biggs, an Australian scholar, in the early 1980s. Its full English name is Structure of Observed Learning Outcome, which means "the structure of the observed students' learning outcomes"[1]. This theory classifies students' learning outcomes into five levels: pre - structural level, uni - structural level, multi - structural level, relational level, and extended abstract level. When specific problems occur, students' thinking levels will lead to corresponding learning behaviors. These learning behaviors, in turn, point to different types of cognitive structures, thus enabling the analysis of the level of students' thinking. By introducing the SOLO classification theory into the geography classroom, teachers can precisely set graded questions according to the students' current thinking stages, gradually facilitate the leap of students' thinking, and thus achieve the in - depth construction, transfer, and application of geographical knowledge.

3 Construction of the question Chain teaching model based on the SOLO theory

3.1 Principles for constructing the teaching model

To break through the limitations of traditional classrooms and achieve in - depth learning and systematic cultivation of thinking abilities, this study proposes the following principles for constructing the high school geography problem - chain teaching model.

3.1.1 Principle of anchoring to the curriculum standards

High school geography problem - chain teaching is by no means a linear "question - and - answer" process. Instead, it involves in - depth exploration and creative reconstruction of the curriculum standards. As the fundamental basis for teaching and evaluation, the high school geography curriculum standards serve as the guiding principle for the construction of this model. Based on the definition of the "problem - chain" concept, all the core questions in the model stem from in - depth analysis of the curriculum standards and accurate understanding of the teaching material content. Compared with the random questioning in traditional classrooms, constructing problem - chain teaching based on the

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SOLO classification theory can embed real - life situations, create suspense gradually, arouse students' interest step by step, and drive students to shift from "answering" to "exploring", achieving a dual improvement in in - depth participation and high - order thinking.

3.1.2 Principle of adaptation to students' learning situation

Faced with the reality that students' thinking levels vary significantly, the design of question chains in geography classrooms should span from easily - answerable anchor points to moderately - challenging scaffolds. The teaching model based on the SOLO Taxonomy Theory takes students' knowledge reserves and thinking development levels into full account as the design basis and conducts a dynamic assessment of the students' learning situation. The question chains no longer aim for a uniform level of difficulty but are like adjustable ladders. When students are thinking actively and have sufficient knowledge, the difficulty of the questions can be rapidly increased to offer challenges. If students encounter understanding gaps, the difficulty can be immediately reduced to fill those gaps before progressing. In this way, it ensures that the starting point of the questions aligns with the students' current learning situation and effectively stimulates their internal motivation for learning.

3.1.3 Principle of logical connection

The question chain is a thinking guidance system composed of a series of questions with a logical progression. Constructing a trinity chain of "question - knowledge - thinking" helps strengthen the knowledge connection and encourages students to progress from low - level memory to high - level analysis and creation. Teachers need to thoroughly analyze the textbook knowledge system. Based on respecting the internal logic of the discipline and guided by the SOLO classification theory, they should construct a well - connected question chain. This design not only ensures the systematic presentation of knowledge but also enables the gradual improvement of students' thinking structure.

3.1.4 Principle of high - order guidance

Questions in traditional classrooms are often confined to "standard answers", while cultivating high - order thinking requires open and challenging question scenarios. The model emphasizes breaking through the key and challenging points in teaching via gradient-based question design. Teachers should transform complex knowledge into a sequence of questions that gradually increase in difficulty, guiding students through a complete thought process from basic understanding to comprehensive application. In this process, students can not only build and transfer knowledge but also develop their comprehensive thinking skills to analyze problems from multiple perspectives and solve them creatively, ultimately achieving the goal of cultivating high-order thinking abilities.

3.2 Ideas for constructing the teaching model

This study constructs a teaching model of geographical question chains in high school under the guidance of the SOLO Taxonomy Theory. The teaching model is shown in Figure 1. The geographical question chain teaching guided by this model can be divided into five teaching steps:

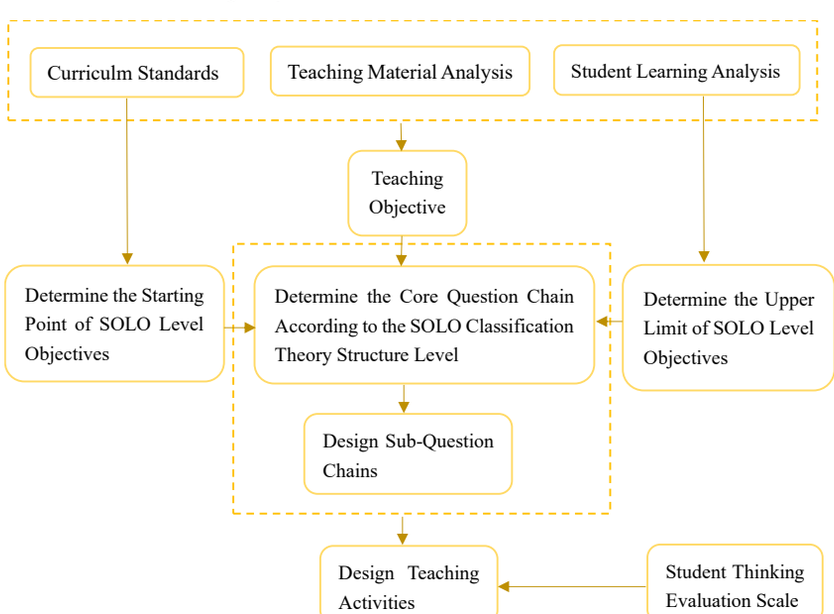

Figure 1 General process for constructing teaching models

4 Demonstration of a geography problem Chain teaching case based on the SOLO theory

The achievement of teaching objectives requires a cognitive process.Specifically, it is necessary to carefully formulate a series of progressive questions that align with the students' zone of proximal development around the teaching objectives. This is what we call the "problem chain" [2]. The design of questions should be integrated with specific teaching contexts, and the creation of these contexts should be based on the content requirements in the curriculum standards [3]. To assist students in better learning about agricultural location factors, this article takes "Gaozhou lychees" as an example to design a problem chain for the lesson "Agricultural Location Factors" (see Table 2).

4.1 Teaching analysis

4.1.1 Curriculum standard analysis

According to the high - school geography curriculum standards, students are expected to be able to identify the dominant factors for the agricultural location selection of a certain type of agriculture or in a certain place. In actual classroom teaching, when choosing agricultural locations, different regions and different types of agriculture have different dominant factors. For example, the main locational factor for animal husbandry is pasture, while for rice cultivation, the main factors are water sources and terrain, etc.

4.1.2 Analysis of the textbook content

According to the requirements of the curriculum standards, this section of the textbook elaborates on three aspects: "the basic definition of agricultural location, the influencing factors of agricultural location, and how to select suitable agricultural locations according to specific environments and conditions", constructing a question chain of "what? why? how?" [4]. Therefore, the knowledge in this lesson is highly systematic and logical. Designing a question chain can better construct the knowledge framework and establish the knowledge system.Through the study of these questions, students can gain a deeper understanding of the factors influencing agricultural location and how to apply this knowledge in practice.

4.1.3 Teaching objectives

Since the questions at the pre - structural level deviate from the teaching objectives and lack practical teaching significance, they will not be considered when formulating the teaching objectives. However, in the actual teaching process, a series of questions targeting students' pre - structural thinking level will be designed to reflect the thinking progression of the SOLO classification hierarchy.

(1) Unistructural: Students can master basic knowledge such as the characteristics and growth conditions of Gaozhou lychees.

(2) Multistructural: Students are able to analyze the influence of natural geographical conditions, such as climate, terrain, and soil, on lychee cultivation in Gaozhou.

(3) Associative structure: By analyzing the locational conditions of Gaozhou lychees, we can establish relationships between isolated knowledge points.

(4) Abstract expansion structure: By exploring the locational factors of Gaozhou lychee cultivation, we can abstractly summarize the case experience and apply it to other regions or industries, and then propose innovative insights and solutions.

Table 1 Question Chain design based on SOLO taxonomy levels

SOLO Levels	Teaching Process	Question Chain Design	Design Intent
Pre-structural Level	Situation Introduction: Play a video of a bumper harvest of Gaozhou lychees, showing farmers picking lychees and piles of lychees.	Ask the students: "Guys, seeing these lychees, what conditions do you think lychees need to grow?"	The teacher asks students in class if they know what conditions are needed for litchi to grow. At this time, some students may just answer intuitively, such as "needing sunlight", with relatively simple thinking and at the pre-structure level.
Single-point structure level: Focus on a single geographical element	Teacher's guidance: "What exactly are the benefits of Gaozhou's sunlight and moisture conditions for the growth of lychees?"	Questioning students: "What direct impact do Gaozhou's climate conditions have on the growth of lychees?" "What kind of water source conditions in Gaozhou are favorable for lychee cultivation? Why?"	Create a scenario based on relevant video materials about Gaozhou lychees, pose questions targeting a certain geographical element of Gaozhou lychees, direct students' attention to a single climate factor, and guide students to use a single knowledge point to answer, initially achieving the single-point structure level.

Table 2 Question Chain design based on SOLO taxonomy levels(Continued).

SOLO Levels	Teaching Process	Question Chain Design	Design Intent
Multi-point structure level: Parallel analysis of multiple elements	Display materials such as the topographic map and soil type map of Gaozhou.	Ask the students: "Why can Gaozhou produce so many high-quality lychees?" "What are the natural geographical conditions for lychee cultivation in Gaozhou?" "How do the topography and soil in Gaozhou respectively affect lychee cultivation?"	The design requires students to consider simultaneously problems of multiple geographical elements that are not yet interconnected, initially cultivating students to analyze problems from multiple isolated aspects and reach the multi-point structure level.
Level of associated structure: Integration of geographical element associations	The teacher guides students to summarize the interrelationships among various physical geographical conditions. Show the topographic maps, yield and output - value maps of Gaozhou, etc.	Ask students the following questions: "How does the topography of Gaozhou affect the distribution pattern of litchi cultivation, and how does this distribution pattern influence the transportation and sales of litchis?" "How do the natural and humanistic environments in Gaozhou shape the brand image of litchi culture, and how does it improve the market competitiveness of the litchi industry?"	By using the materials, students are prompted to establish knowledge connections during the analysis process, develop their comprehensive thinking ability, help them understand the interactions and collaborative relationships among geographical elements, and reach the level of associated structure.
Abstract Expansion Structure Level: Knowledge Transfer and Innovative Application	Show pictures and videos of the Gaozhou Lychee Cultural Festival and introduce the status of lychees in Gaozhou's folk culture. Guide students to abstractly summarize the case experience of Gaozhou lychees and apply it in an expanded way.	Ask students the following questions: "If the lychee industry is to be developed in areas with similar natural conditions but poor transportation and a low - quality labor force, how can we draw on Gaozhou's experience and what issues should we pay attention to?" "If the climate changes, what survival crises will Gaozhou lychees face? What innovative countermeasures are there and what reference can global agriculture draw from them in dealing with climate change?"	The questions require students to deeply understand and comprehensively analyze the geographical background and industrial development of Gaozhou lychees, abstractly summarize the case experience and transfer it to other regions or industries, put forward innovative insights and solutions, and cultivate innovation and transfer abilities.

4.1.4 Teaching evaluation design

Table 3

Class Performance Evaluation	Observe students' performance in classroom discussions and when answering questions, and evaluate their participation, mental engagement, etc. For example, in group discussions, check if they actively share their opinions and can listen to and effectively integrate the opinions of other students. When answering questions, assess whether their thinking is clear and their logic is sound.
Question - Answering Evaluation	Evaluate the extent to which students have achieved the expected thinking levels based on their answers to questions of different levels. For pre - structural and uni - structural level questions, mainly assess students' grasp and basic application ability of fundamental knowledge. For multi - structural level questions, evaluate whether students can analyze problems from multiple angles. For relational structural level questions, focus on students' ability to establish connections between different pieces of knowledge. For extended abstract structural level questions, primarily evaluate students' comprehensive application and innovative thinking skills.
Assignment evaluation	Ask students to select a characteristic agricultural product from their hometown and design an investigation report using the SOLO classification theory to analyze the geographical background, sustainable development strategies, etc. Grade the students' homework. Fully recognize the innovative thinking and practical abilities demonstrated by students in their assignments. Meanwhile, provide specific suggestions for improvement regarding the existing issues.

5 Reflection on case teaching based on the SOLO classification theory

Based on the design of the question chain for the "agricultural location factors" using the SOLO classification theory, this paper guides students to explore problems from different thinking levels by carefully designing the question chain. This approach is feasible to a certain extent but also has some limitations. By carefully designing a question chain that

ranges from the pre - structural level to the extended abstract structural level, students are guided to explore agricultural location factors in combination with real cases, thus improving their thinking and geographical abilities. This hierarchical question - chain design enables students to gain a sense of achievement as they gradually solve problems, achieve the transformation from passivity to initiative, stimulate their learning interest and autonomy, and serve as an innovative example for agricultural geography teaching. However, in actual teaching, there are significant individual differences among students, such as varying knowledge reserves, abilities, and thinking speeds. Even if the question chain is stratified, it's still difficult to adjust the teaching progress to meet the needs of all students. Moreover, this article only takes "Gaozhou lychees" as an example. Agricultural teaching content is diverse, and different cases have their own unique features. Therefore, when applying the question - chain construction model to teaching, it needs to be adjusted and refined, and its universality remains to be verified. Future research and teaching practice should focus on solving these problems, fully tap into the potential, support geography teaching, and promote the all - around development of students.

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