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Original Paper

Research on Structured Teaching of New Textbooks Based on the ISM Method—The Example of "Vegetation and Soil" of the Humanistic Education Edition

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Abstract

This paper adopts the ISM method to study the structured teaching of the chapter "Vegetation and Soil" in the Humanistic Version of High School Geography Compulsory 1. The knowledge structure of the textbook was analyzed by extracting the core elements, determining the relationships of the elements, establishing the adjacency matrix, forming the hierarchical distribution table and constructing the systematic hierarchical directed graph. Based on the analysis results, a sequence of teaching activities and a unit teaching framework were designed, aiming to help students construct a systematic knowledge system. The structured analysis of the content of this chapter using the ISM method can clarify the hierarchical relationship between the geographic elements and determine the teaching sequence of each element accordingly, which can provide certain reference for the teaching of high school geography courses and the analysis of geography teaching materials.

Keywords

ism method, new textbook of human education edition, high school geography, vegetation and soil

Geography textbooks are the basis of teaching for geography teachers, following the cognitive laws of students and cultivating students' geography literacy in a gradual and orderly manner. When designing teaching and learning, the Geography Curriculum Standards for General Senior Secondary Schools (2017 Edition) (hereinafter referred to as the "New Curriculum Standards") should focus on highlighting the core teaching content, and appropriately integrate the thematic content according to the specific needs, so as to enhance the interconnections between the content (Ministry of Education of the People's Republic of China, 2018). In recent years, many scholars and front-line teachers have proposed a series of textbook processing methods: content processing, structure processing, and idea

processing ..... Bruner's structuralist teaching theory emphasizes that the basic structure of a subject is crucial in the learning process, and students should deeply understand and master this basic structure. American educational psychologist Ausubel proposed meaningful learning and divided learning into superior learning, inferior learning, and parallel learning.ISM analysis method is a combination of qualitative and quantitative analysis method, which is able to sort out the disorganized connections among the elements in the system into a multilevel progressive hierarchical structure. In this paper, the system structure model obtained by analyzing the knowledge structure of teaching materials using ISM method clearly shows the hierarchical relationship of knowledge elements. Teachers can flexibly choose teaching methods, adjust learning sequences and strategies, stimulate students' interest, promote the linkage of new and old knowledge, and realize meaningful learning.

1. ISM Analysis

ISM analysis, also known as Interpretative Structural Modeling Method (ISM), is a technique pioneered by Prof. John Warfield in the United States, which aims to analyze complex problems in socio-economic systems by constructing structural models (Tan, 2020). The technique is capable of transforming the fragmented relationships between the elements of a system into an ordered basic structural model. In 1978, Japanese scholar Prof. Takahiro Sato verified that the ISM analysis method is also applicable in the field of goal analysis as well as in the development of educational materials. Subsequently, educational researchers in various countries applied it to the field of education (YU & ZHENG, 2013).

As an analytical tool, the ISM method can clearly reveal the logical relationship between the knowledge elements in the textbook, integrate the originally scattered and isolated knowledge elements into a logical and hierarchical whole, and transform the analysis of the textbook from the traditional way of relying on subjective judgments to a more scientific and objective quantitative research. The visualized knowledge hierarchy distribution table generated by the ISM method can help teachers accurately understand the arrangement idea and knowledge system structure of the textbook. On this basis, teachers can reasonably supplement or reorganize the knowledge elements and optimize the teaching content and sequence according to the teaching needs, so as to carry out geography teaching more effectively and enhance students' learning effect and interest.

2. Operational Process of ISM Analysis

The process of ISM method generally includes five steps: extracting the core elements, determining the element relationships to form the relationship directed graph, establishing the adjacency matrix, finding the remaining target matrix, forming the hierarchical distribution table and establishing the system structure model. If the final model is not ideal, it can be continuously modified until the optimal result is obtained.The general process of ISM method is shown in Figure 1.

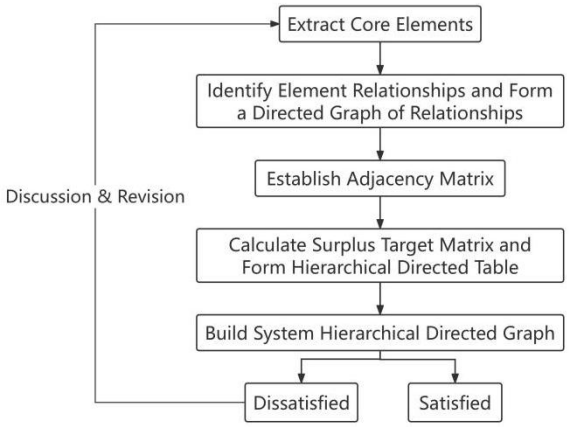

Figure 1. Flow Chart of ISM Method

3. ISM Analysis of the "Vegetation and Soil" Content of the HLM Version

In this paper, we take Chapter 5 "Vegetation and Soil" of the New Humanistic Version of High School Geography as the object of study, and use ISM analysis to analyze the content of this chapter in depth, and get the corresponding teaching material structural model, which lays the foundation for the final analysis.

3.1 Extraction of Core Elements

The extraction of core elements is the first step in analyzing the textbook using the explanatory structural modeling method. In order to reduce the subjective factors affecting the extraction of core elements and to improve the scientificity, the extraction of core elements should satisfy the following conditions: first, the key principles, definitions, and concepts explicitly presented in the textbook; second, in line with the content requirements of the new standard; third, with highly summarized chapter and subsection headings; and fourth, with the knowledge elements are at the key nodes of the chapter system. According to the new standard and the textbook, combined with the above conditions for the extraction of knowledge elements, the knowledge elements of Chapter 5 "Vegetation and Soil" of the New Humanistic Version of High School Geography Compulsory 1 were extracted and arranged numerically according to the order of the elements in the textbook, and coded as A1, A2, A3,... ...A9, as shown in Table 1.

Table 1. Coding Table for the Core Element "Vegetation and Soil"

encodings	Core elements
A1	plant cover
A2	Main vegetation types
A3	Factors affecting vegetation
A4	situation
A5	ground

A6	human activity
A7	Soil observation
A8	Factors affecting soil
A9	Functions and conservation of soil

3.2 Determine the Relationship between the Elements to Form a Directed Graph of Relationships

After extracting the core elements, it is necessary to clarify what kind of "formative relationship" exists between the core elements. According to ISM analysis, when learning element A is a necessary precondition for learning element B, element A and element B are said to be in a "formative relationship", and A is said to be the prior element in the set of formative relationships, and B is the accessible element.

According to the above provisions, the new humanistic version of high school geography must be 1 chapter 5, "vegetation and soil" knowledge elements of direct relationship analysis, to get the elements of the formation of the relationship table, as shown in Table 2.

Table 2. Relationship between the Elements "Vegetation and Soil"

Reachable elements	Preceding elements
A1	
A2	A1
A3	A1
A4	A1, A2, A3
A5	A1, A2, A3
A6	A1, A2, A3
A7	A1, A2, A3, A5
A8	A1, A2, A3, A5
A9	A1, A2, A3, A5

3.3 Formation of the Adjacency Matrix

According to the above elements to form a relationship table, the development of the adjacency matrix, the matrix rows indicate that the elements can be reached, the columns indicate that the first elements, if there is a "formation relationship" between the two rows and columns of the "1" is filled in, and there is no relationship, then do not fill in, as shown in Table 3.

Table 3. Neighborhood Matrix of Core Elements of "Vegetation and Soil"

	A1	A2	A3	A4	A5	A6	A7	A8	A9
A1		1	1	1	1	1	1	1	1

A2			1	1	1	1	1	1
A3			1	1	1	1	1	1
A4								
A5						1	1	1
A6								
A7								
A8								
A9								

3.4 Derive the Remaining Target Matrix to Form a Hierarchical Distribution Table of Core Elements

By looking at Table 3 of the adjacency matrix, it can be found that the first column is all blank, indicating that element A1 has no direct elements, so A1 is located at the bottom of the element relationship hierarchy diagram, and is defined as the first layer of elements. Then, all the "1" in the row where A1 is located are replaced with blanks, so as to obtain the remaining elements matrix, as shown in Table 4.

Table 4. Matrix of Remaining Objectives for "Vegetation and Soil"

	A1	A2	A3	A4	A5	A6	A7	A8	A9
A1									
A2				1	1	1	1	1	1
A3				1	1	1	1	1	1
A4									
A5							1	1	1
A6									
A7									
A8									
A9									

Observing the matrix of remaining elements Table 4, it can be determined that the elements of layer 2 are A2, A3. and so on, until the whole matrix takes all the values of blank. Finally, a total of 4 layers of sub-elements are obtained: A1 is located in layer 1, A2 and A3 are located in layer 2, A4, A5, A6, are located in layer 3, and A7, A8 and A9 are located in layer 4. As a result, all the sub-elements form a hierarchical distribution table, as shown in Table 5.

Table 5. Hierarchical Distribution of "Vegetation and soil" Elements

level	key constituent
1	A1
2	A2, A3
3	A4, A5, A6
4	A7, A8, A9

3.5 Constructing System Hierarchical Directed Graphs

Combined with the formation relationship table 2 and the hierarchical distribution table 5 the knowledge structure system structure model is drawn, as shown in Figure 2. The hierarchical directed graph graph graphically shows what kind of logical relationship exists between elements in a pictorial way, while presenting the upper and lower hierarchical relationships of elements, which is a scientific pictorial expression of the internal structure of the system, and provides reference suggestions for the analysis and evaluation of the whole system.

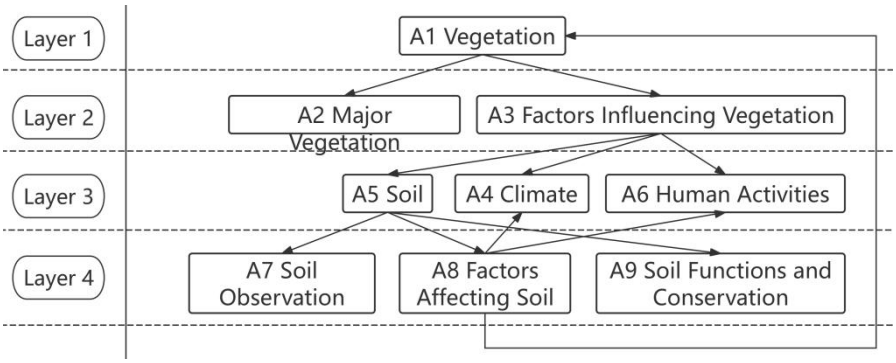

Figure 2. Structural Model of the "Vegetation and Soil" System

3.6 Sequence of Teaching Activities

The real value of textbook analysis lies in applying its results to teaching activities, which should therefore be sequenced according to the hierarchical structure of knowledge elements. When designing the teaching sequence, teachers should also take into account the following three aspects: first, lower-level knowledge should be taught before higher-level knowledge; second, basic knowledge elements should be prioritized at the same level; third, teachers can change the order of elements in the knowledge structure model diagram according to the difficulty level of the textbook and the learning situation of the students.

As a result, the following teaching sequence for "Plants and Soil" is obtained, as shown in Fig. 3, which shows that the sequence of teaching activities obtained through the ISM method is roughly the same as that of the textbook. On this basis, teachers can flexibly adjust the teaching activities according to their

own teaching experience and understanding of students' cognitive characteristics.

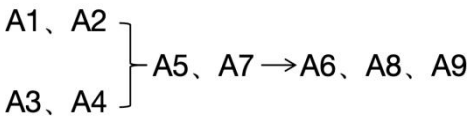

Figure 3. Sequence of Teaching Activities "Vegetation and Soil"

4. "Vegetation and Soil" Teaching Design

In order to promote the effective implementation of the core qualities of geography and help students build a systematic learning content system, the following is a unit teaching framework based on the analysis of the teaching materials of the section "Vegetation and Soil". The framework requires teachers to carry out systematic teaching design at the macro level, build a complete knowledge system based on the core concepts and main concepts, and form a clear main line of knowledge progression. At the same time, teachers also need to carefully design specific teaching content at the micro level to guide students to apply what they have learned to solve practical geographic problems, so that they can deeply understand the importance of the sustainable development of vegetation and soil.

Table 6. Teaching Framework Design for the Unit "Vegetation and Soil"

Topic: Why has green poplar become synonymous with Qinghai?			
Thematic issues	**lesson time**	**Knowledge content**	**educational content**
What type of vegetation does green poplar belong to?	Lesson 1: Vegetation Lesson 2: Vegetation and the environment	A1 Vegetation A2 Main vegetation types A3 Factors affecting vegetation A4 Climate	1. Concept of vegetation 2. Different vegetation types 1. middle school geography climate types, wet and dry regions and temperature zones 2. Relationship between different vegetation types and the environment
What nature of soil does green poplar grow in?	Lesson 3: Soil	A5 Soil A7 Observation of soil	1. Experiment to observe soil color 2. Experimental observation of soil texture 3. Experimental observation of soil profile structure

What are the problems caused by cutting large quantities of green poplar?	Lesson 4: Vegetation, Soil and Human Activities	A6 Human activities A8 Factors affecting soil A9 Functions and conservation of soil	1. Explore the process of soil formation 2. Analyze the factors affecting the soil 3. Impact of human activities on vegetation and soils 4. Sustainable development of vegetation and soils

5. Summary

The important mission of teachers is to sort out the content logic of teaching materials, so as to buttress the internal logic of the subject and find the fit between the laws of teaching materials and the cognitive laws of students (XU & DING, 2023). Applying the ISM method to geography textbook analysis combines qualitative and quantitative research methods, which can structure and sequence the implicit knowledge elements of the textbook and provide geography teachers with a more objective way of analyzing the knowledge structure of the textbook.ISM analysis creates a hierarchical systematic structural model by sorting out the logical relationships between knowledge points, enabling teachers to optimize and design classroom teaching accordingly and helping students to into a structured knowledge system. This system not only integrates the knowledge points, but also reveals the intrinsic connections between them, which not only facilitates students' understanding and summarization of new knowledge, but also helps review and deepen learning, thus promoting meaningful learning.

In this paper, the ISM method is used to analyze the chapter "Vegetation and Soil" in the compulsory first textbook of high school geography of the Renjiao edition, to determine the sequence of teaching activities in this chapter, according to the cognitive ability of the students and the time schedule of the course and other factors, and combined with practical cases to design a thematic unit of the teaching framework design "Qing Yang Why has it become synonymous with Qinghai?" The specific teaching sequence is arranged as follows: 1. What type of vegetation does the green poplar belong to? (Integration of vegetation and environment, 2 hours); 2. What kind of soil does the green poplar grow in? (Soil, 1 lesson); 3. What problems will be caused by cutting down green poplar in large quantities? (Integrated Teaching of Vegetation and Soil Sustainability, 1 lesson). Such a teaching sequence can connect the four lessons through actual cases, and finally through the integrated teaching of "integrated teaching of sustainable development of vegetation and soil", students will deeply realize that: human production and life are not only constrained by vegetation and soil, but also human behavior is constantly affecting vegetation and soil, and there is a close and interpenetrating relationship between the two. There is a close and interpenetrating relationship between the two.

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