

# Design Of Geological Study Tour in Siming Mountain

Jiaqi Xu, Zikai Ding

Zhejiang Normal University, Jinhua, Zhejiang, 3321004, China

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**Abstract:** To enhance the effectiveness of geographical field studies, cultivate students' core geographical literacy, and promote their long-term development, this paper leverages the abundant geological resources of Siming Mountain in Ningbo, Zhejiang. Guided by the UbD theory and integrating the 5C model, it reconstructs a geological field study programme for Siming Mountain. Through a three-stage reverse design process, the plan focuses on cultivating geological practical skills and comprehensive thinking, constructing a scientifically rigorous chain of geological study activities. A multidimensional evaluation scale combining quantitative and qualitative measures is established, providing a new paradigm for geographical study programme design.

**Keywords:** UbD theory, 5C model, geological practical skills, Siming Mountains, field studies

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## 1. UbD Conceptual Framework and Process

### 1.1 Overview

UbD, translated as "Understanding by Design", proposes a results-oriented approach. It emphasises key elements in teaching such as big ideas, essential questions, and WHERE TO (a series of assessment indicators within teaching). It employs reverse design for curriculum models, teaching strategies, and assessment modes to construct a framework for understanding [1]. Its primary aim is to overcome the shortcomings of conventional instructional design, where teachers often overemphasise activities and excessive information delivery. The "backward design" approach advocates starting from the intended learning outcomes and employing reverse thinking [2].

### 1.2 Process

The three-stage UbD-based backward design process involves: defining expected outcomes → determining assessment evidence → designing learning plans. This structured approach facilitates implementation in geography teaching.

## 2. Geography Field Study Design Approach Based on UbD Theory and the 5C Model Assessment Framework

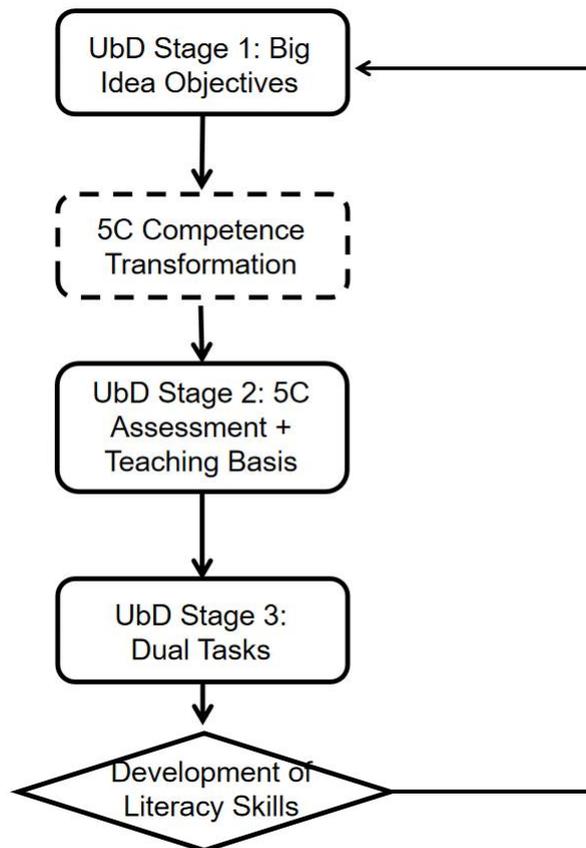
### 2.1 Overview

The 21st Century Core Competencies 5C Model was developed collaboratively by the China Education Innovation Institute at Beijing Normal University and the American 21st Century Learning Consortium. Building upon the 4C Model, it incorporates an additional competency: Cultural Competence. The five competencies are: Cultural Competence, Critical Thinking, Creativity, Communication, and Collaboration. The five competencies of the 5C Model delineate essential 21st-century core competencies from distinct perspectives. While each has its own emphasis, they are closely interconnected, forming an integrated whole [3].

Traditional research-based learning often lists knowledge points without linking them to core geographical competencies, employing overly simplistic assessment systems that fail to quantify student outcomes. Integrating the UbD philosophy with the 5C model's assessment framework ensures activity alignment with objectives and quantifiable results.

## 2.2 Specific Pathways

Firstly, establish dual-objective anchoring for expected outcomes. Drawing upon UbD principles, extract overarching concepts—such as those derived from curriculum standards—then translate these through 5C competency objectives to ground them in specific modules. Secondly, define assessment evidence by integrating specific evaluation criteria with classroom progression. Finally, design a dual-drive mechanism of learning and experience, incorporating experiential activities to enrich geographical learning. The research-based learning design framework is illustrated below.



**Figure 1: Geographical Field Study Design Framework**

### 2.2.1 Phase 1: Big Idea Objectives

For the core concept objectives (curriculum requirements), geological field studies primarily encompass: using geological timelines and related materials to outline Earth's evolutionary processes; identifying 3–4 landforms through field observation or visual media and describing their key landscape characteristics; employing schematic diagrams to explain lithospheric material cycles; and using examples to explain how internal and external forces influence surface morphology changes, while clarifying the relationship between human activities and landforms.

In truth, these overarching concepts encompass smaller objectives such as: understanding the formation processes of various landforms; analysing the impact of human activities (tourism development, hydraulic engineering) on geological environments and proposing conservation strategies; and establishing the natural and cultural connections within the "Sichuang Rock-Siming Mountain-Mingzhou" toponymic chain. However, these smaller objectives cover disparate knowledge points that cannot be seamlessly integrated into research tasks, necessitating further transformation through the 5C model.

## 2.2.2 5C Competency Transformation

**Table 1: Preliminary Objectives Derived from the 5C Model**

5C Competencies	Objective
Communication	Through discussions with teachers and peers, students can gain an initial understanding of the characteristics of relevant geographical phenomena through communicative learning.
Critical Thinking	By comparing the similarities and differences between similar landforms, students understand the distinctions and connections between internal and external forces;  Through field investigations, students can analyse and verify the formation processes of relevant landforms, proposing a coherent geological evolutionary logic chain.
Cultural Competence	Interpret the historical and cultural significance and origins of geological heritage sites.
Creativity	Through observational learning and inductive reasoning, design topographical models or produce schematic diagrams.
Collaboration	Students can complete field tasks such as sample collection and measurement through group collaboration, and jointly discuss the causes of landform formation.

## 2.2.3 Stage 2: Determining Assessment Evidence

Integrating the big idea curriculum standards with the 5C model assessment framework, employing a blended approach of formative and summative evaluation.

**Table 2: Assessment Rubric**

Assessment Format	Assessment Criteria	Assessment Content	Evaluator			Total Score
			Self-Evaluation	Peer-Evaluation	Teacher-Assessment	
			20%	20%	40%	
	Cultural Competence (15 marks)	I.Students can identify the spatial relationships and historical-cultural functions of the place-name chain by understanding the terms "Sichuang Rock - Dayu Mountain - Siming Mountain - Mingzhou" (8 marks);				

		II.Through field investigations, students can comprehend the historical value and documentary evidence underlying geological relics (7 marks).			
Critical Thinking (15 marks)		I.By observing and comparing the mineral compositions of basalt and granite, and utilising field geological evidence alongside online literature, students can scientifically analyse the genesis of ancient peneplains (7 marks); II.Through independent inquiry, accurately apply textbook knowledge to the field setting to identify three distinct landforms (8 marks).			
Creativity (15 marks)		I. Students sketch preliminary diagrams of landform evolution through tactile observation, integrating aesthetic appreciation with scientific rigour (5 marks); II. Students utilise materials such as clay and gravel to construct a three-dimensional teaching aid simulating the Siming Rock formation's structure "upper gravel cave + lower igneous rock base" (10 marks).			
Communication (15 marks)		I.Demonstrate the ability to articulate personal viewpoints clearly during group discussions, accurately comprehend differing perspectives from peers, and engage in reconstructive thinking to enhance understanding (7 marks); II.During interviews with villagers, clearly formulate questions and provide reasonable interpretations of responses to effectively gather information on soil			

		erosion in Huoyan Mountain (8 marks).				
	Collaboration (15 marks)	I.Students reasonably allocate tasks within the group to complete sample collection, measurements, and model construction (8 points); II.Students demonstrated their strengths within group collaboration, making a meaningful contribution to the joint creation of posters/models (7 points).				
Final Assessment	Outcome Presentation (25 marks)	I.Produce a relevant model for Sichuang Rock, demonstrating both scientific literacy and creativity (10 marks). II.Organise and summarise acquired knowledge from multiple perspectives, completing reflection questions, corresponding tables, and drafting an investigation report (15 points);				

### 2.2.4 Phase 3: Dual-Track Tasks

Specifically, the research and study programme design, as detailed below.

### 3.Geological Study Programme Design for Siming Mountains

Based on the UbD theory, implement dual-track tasks in Phase 3. Adopt a student-centred approach with teacher support, enabling pupils to apply textbook geological concepts to real-world contexts. Details are outlined in Table 3 below.

**Table 3: Phase 3 Research-Based Learning Content Design**

Time	Location	Activity
9:00–11:00	Siming Mountain National Geopark - Geological Exhibition	I. Prior to the study tour commencing, teachers shall assign investigative tasks in advance; II. Teachers lead students through the Siming Mountain Geological Exhibition Hall, posing exploratory questions such as "How did the ancient planation surface form?" or "Why do summit lakes persist long-term?" Students gain geographical knowledge about the Siming Mountain region, including its geological features and

	Hall	landforms;  III. Students examine rock specimens, comparing lithological variations, jointing patterns, and weathering differences.
12:30–13:30	Siming Mountain National Geopark - Planation Surface and Basalt Terrace	I. Students conduct preliminary observations of the landforms and their local characteristics. Each student sketches a schematic cross-section of the planation surface and basalt cover, summarising its features and discussing identified issues with peers and teachers.  II. Working in groups, students use magnifying glasses and the Geological Cloud App to compare mineral compositions between basalt and granite, discussing the formation mechanisms of the ancient planation surface.
14:00-15:00	Siming Mountain National Geopark - Stone Great Wall	I. Working in groups, students shall measure columnar joint diameters and orientation using surveying tools and field observation. They shall annotate joint characteristics and analyse their relationship with magma flow direction.
15:30–16:00	Siming Mountain National Geopark - Guigu Rock	I. Students shall document the layered exfoliation patterns of spheroidal weathered rock through field notes and hand-drawn sketches. They shall illustrate the evolutionary process of the Partridge Rock formation and summarise the causes of spheroidal weathering.
16:30–17:00	Dalan Town - Sichuang Rock	I. Students will mark the spatial relationship between "Sichuang Rock-Dayu Mountain-Siming Mountain-Mingzhou" on topographic maps, referencing Tang Dynasty poet Liu Changqing's verses and the Ming Dynasty's Records of Siming Mountain, discussing its function as an ancient geographical coordinate system.

17:00-18:00	Dalan Town - Huoyan Mountain	<p>I. Students conduct preliminary observations and sketch a simplified diagram of Huoyan Mountain's gully formations;</p> <p>II. Students use geological compasses and sample experiments to compare differences between red-bed and granite landforms;</p> <p>III. Students examine the composition of red sandstone and soil pH levels to analyse the environmental characteristics of the Flaming Mountain area;</p> <p>IV. Students engage with local villagers to discuss causes of mountain summit denudation, then create posters proposing solutions for vegetation restoration or soil erosion prevention.</p>
19:00-21:00	Liangnong Town Rest Area	<p>I. Students utilise clay, sand, and gravel to construct a three-dimensional teaching aid simulating the Four Windows Rock's structure: an upper gravel cave overlying an igneous rock base;</p> <p>II. Following model creation, groups engage in discussions to articulate the geological conditions that formed the Four-Window Rock.</p>

The core of geographical field studies lies in enhancing students' geographical learning abilities and cultivating core competencies through the learning process. The development of core geographical competencies occurs as students identify geographical problems, interpret geographical phenomena, and argue geographical issues [4]. Addressing current challenges in geographical inquiry-based learning, this design integrates the three-stage theory of UbD with the 5C model assessment framework. It establishes fundamental questions as the curriculum foundation, employing corresponding evaluation criteria to effectively gauge genuine student comprehension. This informs tailored learning plans [5], enabling educators to better align core objectives with practical implementation throughout the inquiry process.

### References

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