# Construction and Application of a Practice-Oriented Case Bank for General Ecology: A Teaching Reform Framework for Ecological Literacy in Arid-Land Higher Education

Chen Mo[1,2,3], Wang Yang[1,2,3], Li Zhoukang[1,2,3], Zhao Wenxuan[1,2,3], Cai Lu[1,2,3], Zhou Xuelin[4], Jing Changqing[1,2,3]

1. College of Grassland Science, Xinjiang Agricultural University, Urumqi 830052, Xinjiang, China.

2. Key Laboratory of Grassland Resources and Ecology in Western Arid Desert Regions, Ministry of Education, Urumqi 830052, Xinjiang, China.

3. Xinjiang Key Laboratory of Grassland Resources and Ecology, Urumqi 830052, Xinjiang, China.

4. College of Computer and Information Engineering, Xinjiang Agricultural University, Urumqi 830052, Xinjiang, China.

**Abstract**: General Ecology is a foundational course for students in grassland science, ecology, agronomy and related majors, but its concepts are often perceived as abstract and distant from local environmental practice. To address this problem, this paper proposes a teaching reform framework based on the construction and application of a practice-oriented case bank for General Ecology. Guided by ecological literacy, the reform reorganizes course content around authentic arid-land ecological issues, including grassland degradation, oasis agriculture, biodiversity conservation, water use and ecosystem restoration. The case bank contains structured texts, data sets, images, short videos, field tasks and teaching guides, and is applied through a blended teaching process that combines pre-class preparation, in-class inquiry and post-class practice. A comparative evaluation design, including questionnaires, learning portfolios, case reports and performance assessment, is proposed to examine its effects on learning interest, conceptual understanding, analytical ability and problem-solving competence. The framework provides a replicable pathway for improving ecology teaching in regionally distinctive universities.

**Keywords**: General Ecology; case bank; ecological literacy; teaching reform; blended learning; arid-land ecology

## 0. Introduction

Ecology has become an essential knowledge base for understanding climate change, biodiversity loss, resource constraints and ecosystem services. The IPCC synthesis report highlights the need for stronger adaptation and mitigation actions in response to climate risks[1], while UNESCO's recent guidance emphasizes that climate and sustainability learning should be holistic, action-oriented and connected with local contexts[2]. These requirements pose a direct challenge to undergraduate ecology teaching: students must not only remember concepts such as population, community, succession and ecosystem function, but also learn to interpret environmental evidence and propose feasible solutions.

In current General Ecology teaching, several problems remain common. First, knowledge points are often organized according to textbook chapters, which may result in fragmented learning. Second, examples used in class may be too general to reflect regional ecological complexity. Third, practical activities are sometimes separated from theoretical teaching, reducing students' ability to transfer knowledge to authentic problems. These problems are particularly evident in arid and semi-arid regions, where grassland degradation, desert-oasis interactions, water scarcity and vegetation restoration provide vivid but complex teaching materials.

A practice-oriented case bank offers a practical solution. It transforms local ecological phenomena，research outputs and field observations into teachable cases，allowing students to connect theory with practice. Recent environmental and sustainability literacy research stresses the integration of knowledge，awareness，skills，attitudes and behavior[3]. Case-based learning in science education also supports active learning through real-life contexts[4]. Therefore，this paper develops a framework for constructing and applying a General Ecology case bank，with the aim of improving students' ecological literacy and providing a reference for similar courses in agricultural universities.

## 1. Teaching Foundation and Design Logic

### 1.1 Ecological literacy as the core learning outcome

The reform takes ecological literacy as its central outcome. In this paper，ecological literacy refers to the ability to understand ecological principles，read ecological evidence，explain environmental change and participate responsibly in ecological problem solving. For General Ecology，this means that learning outcomes should move from isolated concept memorization to integrated understanding. Students are expected to explain why plant communities differ across habitats，how grazing pressure affects grassland structure，why water availability constrains oasis agriculture，and how restoration measures can be evaluated. In this sense，ecological literacy links scientific explanation with practical judgement. It also helps students recognize uncertainty，compare alternative interventions and understand the limits of ecological prediction.

### 1.2 Case bank as a structured teaching resource

A case bank is not a simple collection of examples. It is a structured teaching resource system that links ecological concepts with problems，data，scenarios and tasks. Each case should include a background description，key ecological concepts，guiding questions，data or images，teaching procedures，assessment rubrics and extension resources. Following the project plan，the initial case bank is designed to include about 20 cases covering major modules of General Ecology，such as organism-environment relationships，population ecology，community ecology，ecosystem processes，biodiversity，landscape patterns and applied ecology.

### 1.3 Regional relevance and transferability

Regional relevance is the main strength of the case bank. Xinjiang contains mountains，deserts，oases，wetlands and temperate grasslands，which provide diverse ecological contexts for teaching. However，the purpose is not to limit learning to local knowledge. Each case should help students form transferable ecological reasoning. For example，a case on grassland degradation can lead to discussions of carrying capacity，disturbance，succession and resilience; a case on oasis water use can be connected to ecosystem services，resource limitation and coupled human-natural systems.

## 2. Construction of the Practice-Oriented Case Bank

### 2.1 Selection and classification of cases

Case selection follows four principles: scientific accuracy，curricular relevance，practical authenticity and teaching feasibility. Materials may come from field investigations，published ecological research，long-term monitoring data，local environmental reports and existing course resources. To ensure systematic coverage，the case bank is classified by knowledge module，ecosystem type and teaching objective. For instance，a population ecology case may focus on population growth and interspecific competition，while a restoration ecology case may focus on vegetation reconstruction，soil improvement and monitoring indicators. The 20-case framework can be organized as a matrix: basic theory cases support concept formation; regional ecosystem cases support contextual understanding; comprehensive problem cases support synthesis and decision making. This matrix helps teachers choose appropriate cases for different weeks and prevents the case bank from becoming a loose archive without curricular logic.

### 2.2 Development of multimodal teaching materials

The case bank should include multiple forms of resources. Text cases explain background and core problems; photos and videos make field conditions visible; data sets train students to interpret ecological evidence; maps and diagrams help students understand spatial patterns; field task sheets guide observation and measurement. Each case is accompanied by a teaching guide, including learning objectives, key questions, suggested teaching methods, time allocation, student tasks and assessment standards. This design is consistent with recent higher education reform literature, which emphasizes the alignment of teaching philosophy, course content, pedagogical design and assessment[5].

### 2.3 Quality control and dynamic updating

Quality control is essential for long-term use. Before entering the case bank, each case should be reviewed by course teachers and, when necessary, by specialists in ecology, grassland science or information technology. Review criteria include factual accuracy, conceptual clarity, difficulty level, data reliability and classroom operability. In addition, a dynamic updating mechanism should be established. New field observations, research findings and regional ecological issues can be added each semester, while cases with outdated data or weak teaching effects should be revised or removed.

## 3. Classroom Application Pathway

### 3.1 Pre-class preparation

Before class, students receive a short case introduction, key terms and several guiding questions through a learning platform. The task is not to master all content in advance, but to identify what they already know and what they need to investigate. Teachers may provide short videos, maps or data sheets to stimulate curiosity. This stage helps students enter the classroom with questions rather than passively waiting for explanations.

### 3.2 In-class inquiry and collaborative analysis

In class, the teacher first connects the case with ecological concepts, then organizes students to analyze the problem in groups. A typical procedure includes scenario presentation, concept clarification, data interpretation, group discussion and solution reporting. For example, when discussing grassland degradation, students may compare vegetation coverage, species composition and soil indicators under different grazing intensities. They then use ecological concepts to explain patterns and propose management suggestions. This process combines case-based learning, problem-based learning and collaborative learning, which can increase participation and support higher-order thinking. Teachers should act as facilitators: they provide conceptual scaffolding, correct misconceptions, encourage evidence-based argumentation and summarize links between the case and the chapter objectives. Students should be encouraged to present different explanations before the teacher gives a final synthesis, because ecological problems rarely have one simple answer.

### 3.3 Post-class extension and field practice

Post-class tasks consolidate learning through case reports, reflection logs, field observation or small projects. Students may investigate campus plant communities, compare different restoration plots, analyze public data or design a simple ecological monitoring plan. Research-based learning in environmental engineering has shown that hands-on inquiry can help students frame questions, collect data, interpret results and communicate findings[6]. Therefore, post-class practice should not be treated as an appendix to theory, but as a key stage where ecological reasoning becomes operational competence.

### 3.4 Digital support for blended learning

Digital tools are used to support, rather than replace, ecological observation and discussion. Learning platforms can store case materials, collect assignments, support peer review and record learning traces. Online quizzes can diagnose conceptual misunderstandings, while discussion forums can extend classroom debate. However, blended learning must avoid passive watching and poorly designed online tasks; recent reviews indicate that design limitations and insufficient training are common barriers in higher education blended learning[7].

## 4. Evaluation and Continuous Improvement

### 4.1 Comparative teaching design

To examine teaching effects, the reform may use a comparative design. One or more classes apply the case bank and blended teaching model, while another class follows the conventional lecture-centered model. Both groups study the same key knowledge points and complete comparable assessments. Data can be collected from pre- and post-questionnaires, course tests, case reports, classroom observation and interviews. The purpose is not only to prove whether the reform works, but also to identify which elements need adjustment.

### 4.2 Multidimensional assessment

Assessment should cover knowledge, ability and learning engagement. Knowledge assessment examines understanding of ecological concepts and mechanisms. Ability assessment evaluates data interpretation, problem diagnosis, evidence-based reasoning and communication. Engagement assessment focuses on participation in discussion, contribution to group work and completion of field or online tasks. A portfolio can be used to collect students´ case analyses, field notes, reflection logs and revised reports, forming evidence of continuous development rather than a single final score. In the scoring rubric, conceptual accuracy, use of evidence, logical structure, feasibility of proposed solutions and quality of teamwork should all be included. For field or project tasks, process indicators such as preparation, observation discipline, data recording and revision after feedback are also important. This combination can reduce the excessive dependence on final examinations and better reflect students´ ecological literacy.

### 4.3 Feedback-driven optimization

The case bank should develop through feedback. Teachers review student performance to identify cases that are too easy, too difficult or conceptually unclear. Students provide feedback on case relevance, workload, clarity and usefulness. The teaching team then revises case texts, updates data, adjusts questions and improves rubrics. Over several rounds, the case bank can become a shared teaching resource with stable structure and continuous vitality.

## 5. Expected Contributions and Promotion

The proposed reform has three expected contributions. First, it improves the relevance of General Ecology by connecting textbook concepts with regional ecological issues. Second, it supports student-centered learning by introducing inquiry, discussion, data analysis and field tasks. Third, it provides reusable resources for teachers, including case texts, multimedia materials, teaching guides and assessment rubrics. After classroom validation, the case bank can be shared through the university teaching resource platform and adapted by related courses such as Grassland Ecology, Restoration Ecology, Environmental Science and Rangeland Management. Its modular design also allows other universities in arid and semi-arid regions to select and revise cases according to their own ecological contexts. In the longer term, the case bank may support teacher development as well. Young teachers can use shared cases to improve lesson preparation, while experienced teachers can contribute new cases and peer-review existing ones. Such collaboration can gradually form a course community centered on ecological evidence, teaching reflection and resource sharing.

## 6. Conclusion

A practice-oriented case bank can transform General Ecology from a concept-heavy course into an inquiry-based and context-rich learning experience. By organizing about 20 cases around ecological literacy, regional ecological problems, multimodal resources and continuous assessment, the proposed framework strengthens the connection between theory, practice and feedback. Future work should focus on classroom implementation, empirical evaluation and long-term resource updating. Through iterative improvement, the case bank can contribute to higher-quality ecology education and to the training of students capable of understanding and addressing real environmental problems.

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