

Case study for teaching Tropical Ecology

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Abstract

This study evaluates the effectiveness of employing case studies as a dynamic pedagogical tool in postgraduate Tropical Ecology education. Through qualitative analysis of student engagements and outcomes associated with the Uxpanapa case study in Veracruz (Mexico), we investigate how this approach influences students' critical thinking, problem-solving skills, and participation in ecological debates. Our findings indicate that case studies significantly enhance students' understanding of complex ecological issues and their ability to make informed professional judgments. These insights have profound implications for pedagogical practices in Tropical Ecology, suggesting a shift towards more experiential and problem-based learning methodologies. The evaluated case study model has charted new learning trajectories for students, enhancing their critical and creative thinking skills within ecology.

Keywords: *Case study; graduate education; Tropical Ecology; real-world application.*

1. Introduction

Tropical regions, characterized by their remarkable biodiversity, are pivotal for sustainable development yet face significant socioeconomic challenges. In this context, education, particularly in Tropical Ecology, plays a crucial role in preparing professionals capable of addressing these challenges. The Centro de Investigaciones Tropicales at Universidad Veracruzana (CITRO) has pioneered a graduate program in Tropical Ecology that integrates research with education, focusing on biological conservation and sustainable development. This study aims to assess the pedagogical effectiveness of incorporating case studies, using the Uxpanapa example, to enhance students' learning experiences.

2. Methodological approach

The Ecología Tropical y Conservación Biológica (ETyCB) course within CITRO's master's program introduces students to professional ecological training through a case study-based

approach (Rodríguez, Hernández & Ruiz, 2022). The Uxpanapa case study, chosen for its rich narrative on socio-environmental conflicts, serves as a practical example to apply theoretical concepts taught in the course. This methodological choice is supported by pedagogical theories that emphasize active learning and engagement (Coll, Mauri & Onrubia, 2008; Fuentes & Muñoz, 2015; Herreid, 2005; Wassermann, 1994) as Constructivism and Problem - Based Learning. Our example is an exercise of reflection and exchange of academic, scientific, and technical arguments about the Uxpanapa case, where each student, based on their thesis topic, embodies the role of the involved parties.

The integration of the case study aims to foster a deep understanding of ecological and conservation issues, encouraging students to apply this knowledge to real-world problems. By integrating textbooks and scholarly articles, the course fosters critical and creative thinking, weaving together the history and philosophy of science (Kuhn, 1970; Matthews, 2017; Rodríguez, 2013) with ecological principles. This interdisciplinary strategy enriches students' comprehension of biological conservation. Initially, the curriculum guides students through an exploration of nature's core principles and conservation methodologies. This journey progresses into an epistemic writing task, culminating in a scientific essay that resonates with their thesis theme, thereby enhancing their participation in the Uxpanapa discussion forum.

The Uxpanapa case stands as a pivotal example of political ecology in Mexico (Gómez-Pompa, 2016), presenting a detailed account of the socio-environmental challenges arising from the area's colonization. Chronicled through a diversified disciplinary lenses for over fifty years, this case remains central to discussions on regional development (Mac Swiney, López, Velázquez, Rodríguez & Muñoz 2018). It serves as a practical backdrop to the theoretical underpinnings of the course, bridging academic concepts with real-world environmental dilemmas (United Nations, 2015).

2.1. Uxpanapa case study integration

The Uxpanapa case study is presented after foundational units on ecology and conservation, using multimedia formats to encourage a multidisciplinary analysis (Conacyt, 1975). Uxpanapa Valley has undergone rapid territorial transformation over the last five decades. Particularly, in the 1970s, a planned colonization process began, which sparked a conflict between government representatives and the scientific community, as two visions of regional development clashed. The approach aligns with the course's objectives to enhance analytical skills and proactive problem-solving. The case study's integration into the curriculum is grounded in the theoretical framework of problem-based learning (Barrows, 1986), which supports the development of critical thinking and application of knowledge in practical settings. This case study helped fulfill disciplinary and multidisciplinary learning objectives, focusing on central themes such as biodiversity conservation, sustainable use of natural resources, maintenance of environmental services, and conditions for human well-being. These issues were discussed withing the

disciplinary framework of Tropical Ecology and the corresponding challenges faced by Biological Conservation in the tropics.

3. Results

3.1 Forum for the discussion of the Uxpanapa case

The use of the Uxpanapa case as an educational resource was evaluated among nine students in terms of ten learning objectives. This evaluation employed a rubric comprising four performance levels: unsatisfactory, basic, competent, and outstanding (with no students in this level), yielding the following results:

Table 1. Student performance in case discussion forum

| Learning objective | Criteria | Performance | | |
|--------------------------|--|--------------------|-------|-----------|
| | | Unsatisfactory | Basic | Competent |
| | | Number of students | | |
| Critical Analysis | · Identification of key problems | 1 | 3 | 5 |
| | · Evaluation of relevant variables | | 4 | 5 |
| | · Depth of analysis | 4 | | 5 |
| | · Coherence and clarity | 4 | 2 | 3 |
| | · Originality and creativity | 4 | 5 | |
| Application of knowledge | · Understanding of theories and concepts | 2 | 2 | 5 |
| | · Practical relevance | 3 | 3 | 3 |
| | · Effective application | 3 | 3 | 3 |
| | · Problem-solving | 3 | 3 | 3 |
| | · Creativity and adaptability | 5 | 3 | 1 |
| Research skills | · Information retrieval | 4 | 5 | |
| | · Evaluation of sources | 4 | 5 | |
| | · Synthesis of information | 1 | 7 | 1 |
| | · Application of research to the case | 1 | 3 | 5 |
| | · Presentation of research | 4 | 2 | 3 |
| Problem solving | · Problem identification | 3 | 2 | 4 |
| | · Solution proposal | 4 | 5 | |
| | · Evaluation of solutions | 4 | 4 | 1 |
| | · Solution implementation | 4 | 5 | |
| | · Creativity and originality | 6 | 3 | |
| | · Coherence and clarity of presentation | 4 | 4 | 1 |
| Effective Communication | · Clarity in communication | 4 | 5 | |
| | · Persuasiveness in communication | 1 | 4 | 4 |
| | · Oral skills | 3 | 6 | |
| | · Adaptability to the audience | 2 | 1 | 6 |
| | · Creativity and originality in presentation | 7 | 2 | |
| Teamwork | · Active collaboration | 1 | 3 | 5 |
| | · Appreciation of perspectives | | 2 | 7 |
| | · Effective communication | 1 | 1 | 7 |
| | · Constructive conflict resolution | | 2 | 7 |
| | · Equitable contribution | | 2 | 7 |
| | · Reflection and continuous improvement | | 3 | 6 |

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| | | | | |
|---------------------------------------|---|---|---|---|
| Interdisciplinary thinking | · Understanding of disciplines | | 7 | 2 |
| | · Identification of interdisciplinary connections | | 8 | 1 |
| | · Application of interdisciplinary approach to problems | 2 | 6 | 1 |
| | · Creativity and interdisciplinary innovation | 6 | 3 | |
| | · Interdisciplinary collaboration | | 2 | 7 |
| Ethics and responsibility | · Interdisciplinary presentation and communication | 2 | 5 | 2 |
| | · Understanding of ethical principles | | | 9 |
| | · Reflection on ethical implications | | | 9 |
| | · Social responsibility | | | 9 |
| | · Practical application of ethical principles | | | 9 |
| Adaptability and flexibility | · Communication of ethical decisions | | | 9 |
| | · Openness to new information and perspectives | | 2 | 7 |
| | · Adaptation speed | | 4 | 5 |
| | · Flexibility in proposing solutions | | 3 | 6 |
| | · Continuous learning | | 2 | 7 |
| | · Collaboration in changing situations | | 2 | 7 |
| Self-directed learning and reflection | · Innovation in adaptation | | 9 | |
| | · Self-directed learning | 2 | 2 | 5 |
| | · Reflection on the learning process | 1 | 1 | 7 |
| | · Establishment of learning goals | 3 | 4 | 2 |
| | · Monitoring of progress | 1 | 5 | 3 |
| | · Adjustment of learning strategies | 1 | 1 | 7 |
| | · Documentation and communication of the learning process | 1 | 2 | 6 |

The Table 1 shows student performances according to the 10 learning objectives, and as evidenced, none achieved an "outstanding" rating; likewise, considering the criteria and personal evaluations for each learning, the need for differentiated educational support for students to overcome the limitations determined by this evaluation is recognized. However, it is necessary to explain that the students are in the first six months of their disciplinary training. With this evaluation rubric, lines of improvement can be traced for the case study as an educational resource, as well as educational strategies oriented towards students in a personalized manner. In general, a deficit in research capacity and creative thinking within the disciplinary framework is recognized. Student engagement is assessed through forum participation, initial responses to ecological conservation, a scientific essay, and a self-assessment questionnaire, offering a holistic view of their academic and personal growth throughout the course.

3.2 Student self-awareness of their own learning

Through introspective exercise, students expressed their learning experiences during the course (Table 2), allowing an assessment of the case study as an educational resource. About educational background, some students stated that they did not consider themselves at an

appropriate level for the demands of the course, some recognizing previous educational deficiencies or coming from a disciplinary background different from biology. Among the most significant manifestations, we highlight in the following table:

Table 2. Student self-awareness of their own learning

| Aspect | Student Reflections |
|---------------------------------------|---|
| Self-Leveling | "I recognized the difference in knowledge with my classmates and worked to level myself". |
| Previous Education | "Previously, I was taught to memorize without reflecting". |
| Unlearning Concepts | "The course prompted me to unlearn some pre-established concepts". |
| Academic Skills | "I became aware of my lack of skills in reading scientific articles in English and academic writing". |
| Critical & Creative Thinking | "The course underscored the importance of questioning beliefs and fostering critical and creative thinking in tropical ecology". |
| Interdisciplinary Connection | "The case study highlighted the interconnection of ecological issues with other disciplines, emphasizing the value of multidisciplinary work". |
| Preparation for Unforeseen Situations | "The educational experience prepared me for unforeseen situations, showing the practical importance of case studies". |
| Contextualizing Knowledge | "It aided in contextualizing my thesis problem and learning new ways of constructing knowledge". |
| Substantiating Arguments | "I learned to substantiate my answers and engage in discussions, recognizing the importance of critical and creative thinking". |
| Understanding Complexity | "The course broadened my perspective on the complexity of socio-environmental problems from a professional viewpoint". |
| Discussion and Reflection | "Engaging with different viewpoints in the forum made me reflect and rethink my own ideas, highlighting the need for discussion and reflection in real-life problem-solving". |
| Critical Reflection | "Class discussions offered a new perspective on biological conservation, moving away from a romanticized view to a more theoretical and critical approach". |
| Orienting Thesis Work | "The course helped orient my thesis work, especially in understanding the historical and social contexts of scientific ideas". |
| Course Design | "The critical and creative design of the course allowed for a thorough review of tropical ecology, changing my conception of biological conservation". |
| Philosophical Approach | "The unexpected philosophical approach was enriching, helping me critically assess concepts and beliefs in conservation and ecology". |

4. Discussion and concluding perspectives

The analysis of student reflections and forum discussions reveals an increased engagement and a deeper understanding of ecological concepts. Comparing these findings with existing

literature our study contributes new insights into the effectiveness of case studies in ecology education, particularly in fostering a multidisciplinary perspective and enhancing critical thinking skills. However, we acknowledge limitations such as the potential for selection bias in student reflections and the challenge of directly attributing learning outcomes to the case study method alone. This report outlines a preliminary experience with heuristic value for planning a more comprehensive study. Due to the length constraints of this report, it is not feasible to elaborate on the methodology used to assess student performance during the discussion forum. According to Table 1, this evaluation considered 10 learning objectives and 55 criteria applied by a subject matter expert. Additionally, Table 2 displays student testimonials on their self-awareness of learning through the case study.

In addressing the critical question of how to effectively prepare professionals in Tropical Ecology to lead in the areas of biological conservation and sustainable development within the Mexican tropics, it becomes evident that the dynamic nature of tropical ecosystems demands an innovative postgraduate curriculum. Such a curriculum should centralize case studies as a fundamental element, promoting a learning paradigm rooted in problem-solving and an updated approach to disciplinary education that ensures professional competence. The utility and impact of integrating case studies into Ecology education cannot be overstated. Our analysis of the case study methodology reveals its profound ability to forge new paths in the educational journey of students. It significantly bolsters their critical and creative thinking capabilities specific to ecological contexts, thereby initiating their transformation into research professionals. These professionals are not only well-versed in theoretical knowledge but are also adept at applying this knowledge pragmatically to address the multifaceted challenges of conservation and sustainable development in the intertropical regions.

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