

Peer-review report

Manuscript: *Protecting Blue Horizons – A role-play to make a marine protected area work*

General review

First of all, I would like to congratulate the authors on developing this educational initiative that addresses an important and often insufficiently explored dimension of marine conservation: the competing interests, needs and perspectives that shape the establishment and management of marine protected areas (MPAs).

I particularly appreciate the intention to bring these complex issues into educational settings beyond those directly involved in marine conservation. Role-play can offer an accessible way for people who are unfamiliar with MPA governance to explore the challenges involved in translating conservation objectives into practice, understand the different stakeholders affected by conservation decisions, and develop greater empathy for perspectives that may otherwise remain distant or poorly understood. Such activities can help make visible the social, economic and political processes that influence conservation outcomes, moving beyond a simplified understanding of conservation as a matter of protecting species or ecosystems alone.

I therefore welcome the initiative and the authors' efforts to evaluate its implementation. I also appreciate that the manuscript recognises the importance of moderation, stakeholder dialogue and debriefing. These are valuable starting points for developing educational resources that can support a more integrated understanding of marine conservation.

However, my main concern is that the conceptual framework, the design of the educational activity, the analytical methodology and the conclusions are not sufficiently aligned. While the manuscript advocates an integrated understanding of biodiversity governance, the theoretical framework gives comparatively limited attention to the social dimensions of conservation; the educational design is not described in sufficient detail to assess how these dimensions are addressed; and the analysis and conclusions do not adequately distinguish between the themes expressed during the activity and the learning that may result from it.

I believe the manuscript could make a valuable contribution, but its purpose and claims need to be more clearly defined, and the relationship between the educational resource and the empirical study needs to be strengthened.

Major comments

1. Theoretical framework: integrating the social dimensions of marine conservation

The introduction provides extensive background on biodiversity loss, international conservation commitments and the ecological rationale for marine protection. However, it

gives comparatively limited attention to contemporary discussions of MPA governance, stakeholder participation and the social, economic and political conditions that influence conservation effectiveness.

The manuscript acknowledges that MPAs operate in contexts where conservation objectives intersect with fisheries, tourism, energy development and local livelihoods. Nevertheless, these tensions are not explored in sufficient depth to provide a strong conceptual foundation for the educational activity and the challenges of ensuring meaningful participation in conservation decisions.

This is particularly relevant because the manuscript aims to present biodiversity governance as both a scientific and a socio-political process. The introduction currently devotes considerable attention to the ecological dimensions of the biodiversity crisis, while the social dimensions that justify the use of a stakeholder role-play receive less sustained attention.

This imbalance raises a broader conceptual question. Marine conservation has often been approached predominantly through the natural sciences, while the knowledge, experiences and circumstances of people who depend on or live alongside marine ecosystems have not always been integrated equally into conservation planning and management. The manuscript appears to seek a more integrated approach, but this ambition needs to be more clearly reflected in its theoretical framework.

I encourage the authors to strengthen the introduction by engaging with relevant literature on social-ecological systems, environmental justice, blue justice, participatory governance and the social dimensions of MPA effectiveness that could frame better why all the stakeholders to be mentioned later in the document are relevant.

Related to the theoretical aspects in education, classic educational references can remain where relevant, but they should be complemented by focused and updated research that directly informs the design and evaluation of this type of activity, such as studies focused on the design of role plays to promote environmental education.

Castellazzi, E., Hakkarainen, V., & Raymond, C. M. (2024). Role-play as a catalyst for justice awareness: a relational approach to nature-based solutions with secondary school students. *Ecosystems and People*, 20(1), 2430591.

Chen, J. C., & Martin, A. R. (2015). Role-play simulations as a transformative methodology in environmental education. *Journal of Transformative Education*, 13(1), 85-102.

Rumore, D., Schenk, T., & Susskind, L. (2016). Role-play simulations for climate change adaptation education and engagement. *Nature Climate Change*, 6(8), 745-750.

2. Clarifying the purpose and contribution of the study

The manuscript combines three related but distinct contributions: the development of an educational resource, formative observations from an initial implementation, and a thematic analysis of two subsequent university implementations.

However, the relationship between these components remains unclear. It is difficult to determine whether the primary purpose is 1. to present and validate the role-play as an educational resource, 2. explore the themes that emerge during simulated negotiations (that are already defined before the review of results), or 3. evaluate its contribution to participants' learning.

These objectives require different analytical approaches and forms of evidence.

1. If the manuscript aims to present an educational activity that can be understood and replicated by other educators, a more detailed description of the game design and its different stages is needed. In particular, I would welcome access to the stakeholder briefing sheets, either in the main text or as supplementary material, or at least a structured summary of the information, interests, constraints, objectives and negotiation positions assigned to each role. It would also be helpful to describe the rules and instructions provided to participants, the moderator's guiding questions, and the questions used during the debriefing to reflect on the learning experience.

These details are important not only to understand how the activity works, but also to assess whether the profiles provide sufficiently nuanced and balanced representations of stakeholders and whether the information provided encourages participants to engage critically with competing interests. For example, how are the circumstances of small-scale fishing communities, their livelihood dependencies, restrictions on access to fishing grounds, economic vulnerabilities, and the distribution of conservation costs and benefits represented, if at all?

A clearer account of these elements would help readers evaluate the educational design and understand how the activity addresses the complexity of MPA governance, while enabling other educators to implement and adapt it. Furthermore, it would be useful to consider how the information provided in the briefing sheets may have influenced the topics raised during the role-play and, consequently, the themes identified in the analysis presented in this study. This would help distinguish between topics that participants bring to the discussion based on their prior knowledge and perspectives, and those that may have been prompted by the information provided through the activity.

2. One potentially valuable contribution would be to investigate which dimensions of MPA governance participants spontaneously identify, prioritise or overlook when they are introduced to a conservation conflict. This could provide insights into how people with different educational backgrounds engage with competing

conservation objectives and how an educational simulation might help make these issues accessible to audiences unfamiliar with MPA governance.

3. If the principal objective is to evaluate the educational effectiveness of the role-play (where the debrief analysis is needed in my opinion), the manuscript would need to explain more clearly how learning outcomes are defined and assessed.

I encourage the authors to formulate an explicit research question and align the study design, analysis and conclusions accordingly. Clarifying this distinction would substantially strengthen the manuscript.

3. Interpreting the thematic analysis: what does the presence or absence of a theme tell us?

The manuscript uses directed thematic content analysis where each indicator is classified according to whether it appears in both university implementations, only one, or neither.

While this approach offers a descriptive overview of thematic coverage, the rationale for choosing a dichotomous presence/absence approach requires further explanation.

The current analysis does not capture how frequently participants refer to a theme, the context in which it appears, the arguments used to support it, or the significance it acquires during the negotiation. Consequently, the results provide limited insight into how participants construct their positions, negotiate competing interests or engage substantively with different dimensions of MPA governance.

I encourage the authors to clarify why presence/absence coding was preferred over a more detailed analysis of the content and dynamics of the discussions. If the objective is to identify which dimensions of biodiversity governance emerge during the role-play, an analysis combining thematic coding with illustrative excerpts and, where appropriate, descriptive frequency information could provide a richer understanding of the findings.

For example, analysing when and how particular themes emerge during different stages of the negotiation could help distinguish between issues introduced spontaneously by participants and those that become relevant in response to other stakeholders' arguments. Such an approach might also reveal whether certain topics remain peripheral throughout the discussion or become more prominent as the negotiation progresses.

Frequency should not be interpreted as a direct measure of understanding or learning. Nevertheless, combining it with qualitative analysis of the arguments and their context could provide a more informative account of the deliberative process than the current indicator matrix alone.

4. Participant characteristics and disciplinary background

The manuscript reports that the Argentine implementation involved undergraduate Biology students, while the Mexican implementation included students from different disciplines, including environmental sciences, psychology and business administration.

These differences are potentially important for interpreting the findings. Participants' disciplinary backgrounds and prior knowledge may influence which dimensions of MPA governance they recognise, which arguments they consider relevant and how they understand competing interests.

The authors suggest that the stronger representation of ecological and sustainability themes may be particularly relevant in natural science programmes. This is a plausible interpretation, but the available information does not allow the influence of disciplinary background to be assessed systematically.

Please provide further information about the number of participants, their educational backgrounds and any other relevant characteristics of the two cohorts. The manuscript should also discuss how these differences may have influenced the observed thematic patterns and the extent to which the findings can be transferred to other educational settings.

7. Alignment between educational theory, implementation and evaluation

The manuscript discusses the educational potential of role-play but does not fully align its theoretical framework with the implementation and evaluation. Since the two university sessions analysed did not include a formal debriefing, the data reveal which themes emerged during negotiations, but cannot establish participants' understanding or learning outcomes. The authors should distinguish thematic findings from educational outcomes and avoid attributing the limited representation of certain GBF themes to the absence of debriefing (as it happens after the game). As a future development, a structured debriefing followed by a second negotiation round could help explore how participants' arguments and consideration of competing interests evolve due to an intermediate reflection guided by the educator.

8. From identifying thematic gaps to improving the educational resource

The manuscript concludes that future versions of the role-play should integrate justice, equity, benefit-sharing, traditional knowledge and other socio-political dimensions more explicitly into the role descriptions, introductory materials, moderation guidance and debriefing prompts.

I agree with the general direction of these recommendations. However, the discussion would benefit from a more explicit account of how the findings inform specific changes to the resource.

Several explanations could account for the limited representation of particular themes: participants may not have had sufficient prior knowledge; the briefing materials may not have provided relevant information; the negotiation structure may have prioritised other issues; or the facilitation process may have influenced which topics were discussed.

These possibilities have different implications for educational design. Additional information may be needed in some cases, whereas others may require changes to the role descriptions, the structure of the negotiation or the questions used during debriefing.

I encourage the authors to distinguish between these possible explanations and provide concrete examples of how the identified gaps could inform future versions of the activity.

This would help move the manuscript beyond identifying which themes were less visible in the transcripts towards explaining how the role-play could be improved to support more informed, critical and socially grounded engagement with MPA governance.

Overall recommendation

The manuscript presents a valuable educational initiative that could help broaden engagement with the social and political dimensions of marine conservation. However, substantial clarification and revision are needed to strengthen the alignment between its goal, conceptual framework, educational design, analytical approach and conclusions.

I recommend that the authors clarify the primary purpose of the study, provide greater transparency regarding the role descriptions and coding procedures, present the empirical findings in a more interpretable form, and moderate claims about educational effectiveness where learning outcomes have not been directly assessed.

With these changes, the manuscript could make a useful contribution, either as an exploratory study of how participants engage with competing perspectives on MPA governance or as a description and formative educational resource. The key is to define this contribution clearly and ensure that the claims made are supported by the evidence presented.