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Gaming Across Boundaries: The MSP challenge as boundary object for learning in maritime spatial planning communities

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ABSTRACT

Maritime Spatial Planning (MSP) is a politically guided and stakeholder-driven process involving a range of actors (i.e., planners, stakeholders, scientists, and citizens). Theories of boundary objects offer a lens to understand how actors, in the context of decision and policy-making in organizations, can coordinate without consensus. This seems particularly relevant when institutions and communities are relatively young, and the body of knowledge is fragmented and fluid, such as in the case of MSP. A key question is whether, and how boundary objects can be intentionally designed and used to facilitate social and policy learning in such communities. In this research, the focus is on the use of the MSP Challenge serious games as a boundary object to facilitate learning in 'Communities of Practice' (CoP) around MSP. Data were collected through questionnaires of 62 MSP Challenge workshops between 2016 and 2020 with more than 1100 participants. Additionally, 33 interviews with key stakeholders were conducted. The findings show that the MSP Challenge is widely used for various goals and in various settings and that they are interpreted differently by different users. The success of the MSP Challenge relies on the boundary space in which it is implemented, taking into account discrepancies in learning due to variations in the backgrounds and attitudes of the participants towards the object, the activity, and the setting in which it is deployed.

1. Introduction

Maritime spatial planning (MSP) is a policy approach for dealing with the organization and regulation of the use of the marine environment in time and space in order to achieve economic, social, and ecological objectives in a continuously changing environment (Ehler and Douvere, 2009; Ehler et al., 2019). MSP emerged in the early 2000s in response to challenges like significant biodiversity loss and the need for space for new (wind energy) developments (Jay et al., 2013), and it became a dominant approach to manage human activities, and balance human uses with nature conservation (McAteer et al., 2022; Flannery et al., 2019). The complexity of marine environments and the socio-political challenges of MSP—due to conflicting interests, uncertainty, and ambiguity—require that planners and other policy-makers have diverse skills to ensure effective and legitimate decision-making (Calado et al., 2019; Ansong et al., 2021). These include project management, strategic thinking, stakeholder engagement, communication, negotiation, and mediation skills Calado et al., (2019); Ansong et al., (2021).

Policy support tools can help to develop and improve these skills and competences as well as assist in developing and implementing MSP. According to Pinarbasi et al., these tools can help planners achieve their tasks in a "more systematic and objective way" (Pınarbaşı et al., 2017: 85). Various policy support tools have been developed and used within MSP to facilitate decision-making and stakeholder engagement (Pınarbaşı et al., 2017; Stelzenmüller et al., 2013; Queffelec et al., 2021), including Environmental Impact Assessments, zoning tools (i.e., MARXAN), and GIS tools. Also serious games, such as the MSP Challenge serious games, are increasingly used within the context of MSP. The MSP Challenge serious games aim to contribute to the international learning process of MSP. Since 2011, the MSP Challenge serious games have been used worldwide in different settings and for different purposes

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(Abspoel et al., 2021; Keijser et al., 2018).

Serious games are a type of policy support tool in which people – as actor or stakeholder – with stakes, tacit knowledge, emotions, and intuitions are an intrinsic part of the tool (Mayer, 2009). While there is no universal definition of serious games, they are generally considered to be simulations of real-world events or processes designed to contribute to solving problems (Ibarra et al., 2020; Ratan and Ritterfeld, 2009). Mayer defines serious games as "experi(m)ent(i)al, rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game" (Mayer, 2009: 825). Serious games are increasingly being used in complex policy processes, based on the assumption that their use could lead to social and policy learning (Santos et al., 2020), and, in this way, these tools are assumed to contribute to the effective and legitimate development and implementation of policies.

The objective of this paper is to gain insight from the MSP Challenge serious games as a policy support tool, particularly for enhancing learning in transboundary MSP. We conceptualize the MSP Challenge serious games as a boundary object to understand how these games are (differently) interpreted and used, because boundary objects, such as artifacts or theories, offer means to align different perspectives and interests (Star and Griesemer, 1989) and enable knowledge sharing across boundaries (Bechky, 2003; Carlile, 2004). According to Akkerman and Bakker (2011), boundary objects not only help coordinate and facilitate collaboration across boundaries, but also provide insight into whether and how practices differ from each other, viewing one's own practice from a different perspective, and jointly transforming (new) practices (Akkerman and Bakker, 2011). Although boundary objects do not automatically lead to learning and might even constrain learning (Bechky, 2003; Clarke, 2021), the concept allows us to analyze the role of policy support tools, like the MSP Challenge serious games, in contributing to learning. Our research question for this paper is: How and to what extent does the MSP challenge as a boundary object contribute to learning in MSP?

In order to understand whether and how serious games contribute to learning in MSP, we built upon the work of Stange et al. (2016) to conceptually link boundary object thinking (including the concepts 'boundary activity' and 'boundary space'), to processes of learning, distinguishing between individual, social, organizational, and policy learning. We draw on the case study of the MSP Challenge serious games. The paper proceeds as follows: Section 2 presents the conceptual framework. Section 3 presents the case study and data collection methods. In section 4, the MSP Challenge serious games are analyzed. Discussion follows in section 5, which addresses the strengths and limitations of the framework, and section 6 draws conclusions.

2. Learning in a boundary space: a conceptual framework

2.1. Boundary objects

Boundaries quite literally determine what (or who) is in and out, reflecting "a fundamental social process, that of relationality" (Lamont and Molnár, 2002: 169). Boundary thinking is, therefore, powerful in the analysis of social interactions, such as in the exchange of different forms of understanding when learning. While the boundary work by (Gieryn, 1983) is generally known for its emphasis on contrasting and delineating scientific and non-scientific knowledge, Star and Griesemer (1989) focus on the ways different interpretations may converge at boundaries, using the concept of "boundary objects" (e.g. (Riesch, 2010; Stange et al., 2016)). Looking into the ways in which policy support tools can facilitate or enhance learning, the latter approach is particularly useful. Star and Griesemer (1989: 393) state that boundary objects "are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites". They are representational forms—artifacts or theories—used in different ways (or interpreted differently) by different communities (Star and Griesemer, 1989), while offering a means to collaborate without necessarily coming to a consensus (Star, 2010). According to Star, a defining characteristic of boundary objects is their ability to "tack back and forth" between specific and abstract, whereby a "loosely-structured object" that is used in a multi-actor setting takes on more concrete features when examined from the specific perspective of one group (Star, 2010: 605; Stoytcheva, 2015: 4). A well-known example is the map of California in which professional biologists saw mainly life zones on the map, while amateur conservationists emphasized trails and camping areas, showcasing that the internal ambiguity, but the common boundaries of the map, allowed different types of knowledge from different actors to be brought together to achieve a more complete understanding of the area (Star and Griesemer, 1989; Flannery et al., 2019). This example also shows that users can have different interpretations of the same object and/or use the object differently.

Boundary object as a concept is further developed and applied to analyze the nature of cooperative work in the absence of consensus (Star, 2010), and is widely used in different disciplines. A review of knowledge management literature shows the diversity of objects serving as boundary objects, such as excel workbooks, decision support systems, management plans, and presentations (Kanwal et al., 2019). Several examples of boundary objects can also be found in the literature on natural resource management, such as 'Ecological indicators' (Turnhout, 2009), 'Significant effect' (Floor et al., 2016), 'Wadden Sea Barometer' (Van Enst et al., 2018), and 'Waddenhouse Deliberation ranking' (Van Enst et al., 2018). For MSP, this can be material artifacts such as maps (Walsh, 2019; Clarke, 2021), but also new policy support tools, like serious games, specifically designed to facilitate learning and communication between planners and stakeholders. While the application of serious games in MSP, particularly the MSP Challenge, has been studied (Abspoel et al., 2021; Keijser et al., 2018), it has not yet been analyzed through the lense of boundary objects. This would, however, shed light on the possibilities for (flexible) use of the serious game as a policy support tool, and particularly on its role in converging the multiple interpretations of MSP.

Although boundary objects can be designed in theory, most boundary objects arise more organically in situations where various actors interact with each other to solve a problem (Bowker and Star, 1999; Star, 2010; Stoytcheva, 2015). The form or structure of the object follows the needs of different users; the form is tailored by the users themselves to enable specific activities across boundaries. Through use, boundary objects can thereby enable different learning mechanisms. According to Akkerboom and Bakker, boundary objects can help identify whether and how practices differ from each other, reflect on one's own practice from the perspective of another practice, learn to collaborate with each other across boundaries, and jointly transform or develop (new) practices (Akkerman and Bakker, 2011; Jean et al., 2018; Bronkhorst et al., 2019.)

2.2. Learning through objects and activities in a boundary space

According to Stange et al. (2016), an object does not stand alone but is developed by actors for a particular reason, while the object's use and/or application takes place as part of an activity (Stange et al., 2016). In other words, an activity and object are intrinsically linked where an activity is often instrumental to the application of the object (Stange et al., 2016). A boundary activity is an activity of at least two people in which an object performs as a boundary object in exchanging information, knowledge, viewpoints, perspectives etc. Examples of boundary activities are telephone calls, meetings, workshops, field visits, and conferences. The activity takes place within a specific context, or boundary space, that determines how and why the object performs as a boundary object. Actors interact and meet with other actors in a boundary space, and this interaction is often triggered by an object. The boundary space enables actors to share, transfer, and translate their

knowledge because it frames the purpose of the activity (Stange et al., 2016; Carlile, 2004). In other words, boundary activities, e.g., activities that are instrumental in making objects function as boundary objects, are organized for a specific reason.

Building upon the work of Stange et al. (2016), we argue that the interplay of an object and activity within a boundary space is crucial for learning. For example, a good PowerPoint presentation (object) about MSP would have no learning effect if shown during a kid's soccer match (activity), where the participants in this boundary space (local leisure/community sphere) are not familiar with the topic of the presentation. In this example, some individual learning about MSP might still take place, but it is not likely to have an effect in the policy field.

Our analytical framework (Fig. 1, based on (Stange et al., 2016)) captures the interplay between boundary object, activity, and space, but also emphasizes different types of learning: individual learning, social learning, organizational learning, and policy learning. Individual learning depends on the knowledge and experience that actors bring or take with them, and can be triggered by a boundary object in a boundary activity. Social learning can be defined as "the collective action and reflection that occurs among different individuals and groups" (Keen et al., 2005: 196). Boundary activities (such as workshops or team meetings) involve the exchange of knowledge and perspectives between multiple individuals from the same or different organizations. Individual and social learning can both take place in a boundary space, but the results of a collective learning process may differ on an individual level because of one's knowledge and experiences.

Furthermore, most actors are part of an organization and will take what they learn back to their organization (right-hand side of the figure). The extent to what these actors learn is shared with other actors within the organization depends on various factors, including the time and space available for learning and sharing knowledge within the organization (Liu et al., 2021; Holste and Fields, 2010). The extent to which the acquired knowledge is embedded in the organization, organizational learning, depends on the extent to which other organizational actors also internalize this knowledge, so an interplay between individual and social learning within the organization (Senge, 1990; Crossan et al., 1999). Whether or not this also results in policy learning and/or improved decision-making depends on, amongst others, whether the individual is able to influence the policy, and the organizational capabilities to internalize this knowledge (Guentner and Harding, 2015; Sabatier, 1987).

3. Materials and methods

3.1. Case study: MSP Challenge serious games

Because the concept of boundary objects highlights convergence towards shared interpretations, we use a qualitative research approach to analyze the ways in which serious games as boundary objects contribute to learning. We use a case study research design, focusing on the MSP Challenge serious games aimed at facilitating MSP processes using game-based interventions. Since 2011, three types of serious games, namely a role-playing game, a board game, and a simulation platform, have been developed. The development of the MSP Challenge serious games has been initiated by the Ministry of Infrastructure and Water Management in the Netherlands. Several parties were involved in the development of these serious games, including game designers, game developers, and MSP context experts. All these games have been branded the MSP Challenge. The original role-playing game, the 2011 MSP Challenge, has evolved into both a board game and a digital simulation game, with support for the original version ending in 2015. Consequently, this research focuses on the MSP Challenge board game and the MSP Challenge Simulation Platform. These MSP Challenge serious games are one of the few serious games dealing specifically with integrated ecosystem-based MSP (Steenbeek et al., 2020). The differences between the MSP Challenge serious games allow us to comparatively assess how these serious games relate to learning processes in MSP.

Table 1 gives an overview of the similarities and differences between the MSP Challenge board game and the Simulation Platform. The MSP Challenge serious games are similar with respect to their objective namely, participants must jointly develop a maritime spatial plan for their sea area, considering economic, ecological, and social objectives. It is up to the participants to decide how they will do this. The outcome of the game is discussed on two aspects: the result (e.g., the maritime spatial plan) and the process (e.g., how the plan has been realized)

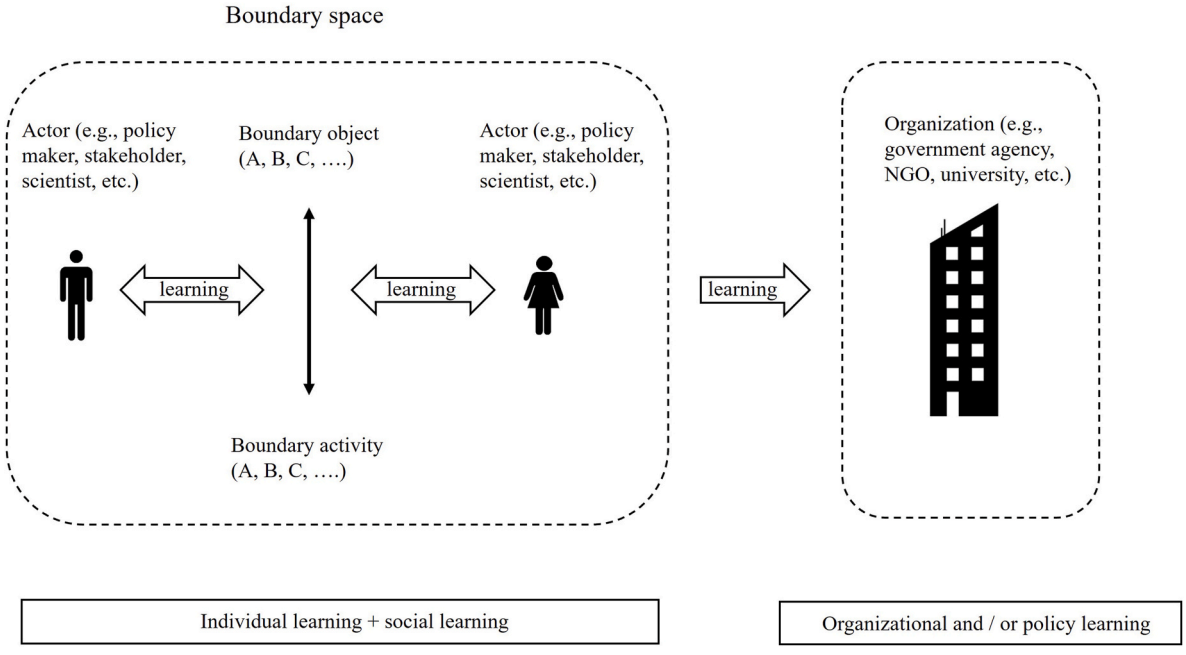

Fig. 1. Boundary thinking framework, distinguishing between boundary space, boundary activity, and boundary object and different levels of learning (i.e., individual, social, organizational, and policy learning) (based upon Stange et al., 2016).

Table 1
Boundary space framework - overview MSP Challenge serious games.

	MSP Challenge Simulation Platform	MSP Challenge board game
Boundary space		
• Educational setting	Training & Education	Training & Education
• Policy intervention setting	Capacity building Stakeholder involvement Scenario development	Capacity building Stakeholder involvement
• Scientific setting	Incorporating & validating models Research on serious games	Research on serious games
Boundary activity		
• Purpose of activity	Education Raising awareness Stakeholder involvement Scenario development	Education Raising awareness Stakeholder involvement
• Target audience	Students Young professionals MSP planners Stakeholders	Students Young professionals MSP planners Stakeholders
• Duration of activity	Min. 3 h until multiple days.	1–3 h until multiple days
• Number of participants	12-30 participants in one workshop	12-30 participants in one workshop
• Location of activity	Physical and digital workshops	Physical workshops
Boundary object		
• Type of game	Simulation game	Board game
• Name of sea basin	Sea of Colours	RICA Sea
• Year of development	Development 2015 – ongoing	Development 2016
• Year of launch	Launched in Riga, February 2018	Launched in Amsterdam, February 2016
• Number of countries	Flexible number of countries 4–7 (depending on sea basin used)	Three countries
• Level of realism	Based upon accurate GIS data (e.g. North Sea, Baltic Sea, Clyde, Adriatic Sea).	Based upon the Gulf of Mexico, but fictive
• Type of roles	All participants are planners	Different roles (planners, stakeholders, NGOs)
• Type of data	Realistic data and maps	Simplified map and information
• Type of technology	Simulation model, including food web calculations	Tokens and threads
• Number of data layers	Flexible number of layers of map information	Different number of tokens and threads
• 1, 2, 3 Dimensional	2D to 3D zoom in	2D
• Materials	2-3 laptops per country, networked	No laptops
• Type of indicators	Performance indicators, dashboard, analytics	Limited performance indicators
• Limitations	Need of ICT support No stakeholder interaction	No simulation Not networked No underlying performance model

(Toonen et al., 2023). Each game is supervised by a moderator and one or more facilitators, usually MSP content experts. During and at the end of the game, facilitators have a discussion with the participants by asking questions that vary from collecting first impressions to more reflective questions about why certain choices were made and how the gameplay resembles MSP in 'real' life (Keijser et al., 2018). On the other hand, the MSP Challenge serious games differ with regard to the use of technology, the type of roles played, and the minimum duration of the workshops.

3.2. Research methods

Within our case study research, we used a mixed methods approach. We combined qualitative and quantitative methods, including interviews with developers, users, and workshop organizers, observations of MSP Challenge workshops, and questionnaires.

3.2.1. Interviews

This study is based on 33 interviews conducted with the developers of the MSP Challenge serious games, workshop organizers and facilitators, and participants from various MSP Challenge Simulation Platform workshops. The purpose of these interviews was to gather information about the background of the games, their application in different contexts, the users' and participants' learning experiences, and the concrete outcomes and impacts of these serious games. These interviews illustrate and support the findings of this study.

3.2.2. Observation workshops

The MSP Challenge development team facilitated various workshops, with involvement from the host organizations. Intermediate discussions occurred during and after all workshops to transfer MSP-related knowledge and stimulate and capture learning. Some workshops were recorded using a time-lapse video, while the results of a few others were documented in a report. The captured observations illustrate and support the findings of this study.

3.2.3. Questionnaires

In total, questionnaires were completed for 62 workshops; 51 MSP Challenge board game workshops and 11 MSP Challenge Simulation Platform workshops. Different types of questionnaires were used for these workshops. For the board game workshops, a brief post-game questionnaire was used that consisted of validated questions and constructs to obtain information on demographics, sector of employment, pre-existing involvement in MSP, experience with the game, and appreciation for and understanding of MSP. For the MSP Challenge Simulation Platform, three questionnaires were deployed (one pre-game questionnaire and two post-game questionnaires). The pre-game questionnaires focused on obtaining background information about the participants, while the aim of the first post-game questionnaire, distributed immediately after the session, was to receive feedback on the gameplay experience and learning potential. The aim of the second post-game questionnaire, sent to all participants 6–9 months after the workshop, was to gain insights into their ability to apply workshop learnings to their daily work, the game's potential for MSP processes, and the extent to which they shared their experiences with others.

In this study, we used descriptive statistics to support our findings on how the MSP Challenge serious games affect learning outcomes and learning experiences. All questionnaires consisted of statements using a 5-point Likert scale (ranging from strongly disagree to strongly agree) covering topics such as materials and facilitation, gameplay enjoyment, various MSP aspects, and adjustments made during the game (see Annex for the questionnaires). The post-game questionnaires also included an open comment section where participants could write anything they wanted, from recommendations for improvements to sharing their experiences.

4. Analysis and results

4.1. Results case study: MSP Challenge board game

4.1.1. Description of MSP Challenge board game

The MSP Challenge board game was originally developed for a high-level meeting to illustrate the relationship between Maritime Spatial Planning and Short Sea Shipping (Keijser et al., 2018). The aim of the game is to jointly develop a fictive sea area, the 'Rica Sea,' on a physical board using tokens and threads that represent human activities (e.g., oil and gas, wind energy), ecological features (e.g., spawning grounds), as well as linear infrastructure like cables and vessels (see also Fig. 2). As the game progresses, the 'Rica Sea' gets busier and busier, and this

Fig. 2. Impression of the MSP Challenge board game.

should encourage participants to 'think and talk' about the interrelationships between the different human activities and the (feasibility of the) different objectives (Keijser et al., 2018; Abspoel et al., 2021).

The MSP Challenge board game is played in a physical workshop setting where participants assume roles (e.g., planner or stakeholder) within country teams. Although the general format of the game is broadly followed, each organizer uses the game activity according to the anticipated and experienced interactions triggered by or during the game. Variations relate to time spent on introduction, the use of game materials, the number and type of roles played, and time spent on debriefing. Some organizers assign roles different from participants' real-life affiliations to foster empathy and enhance discussions. For some specific workshops, organizers have developed additional game

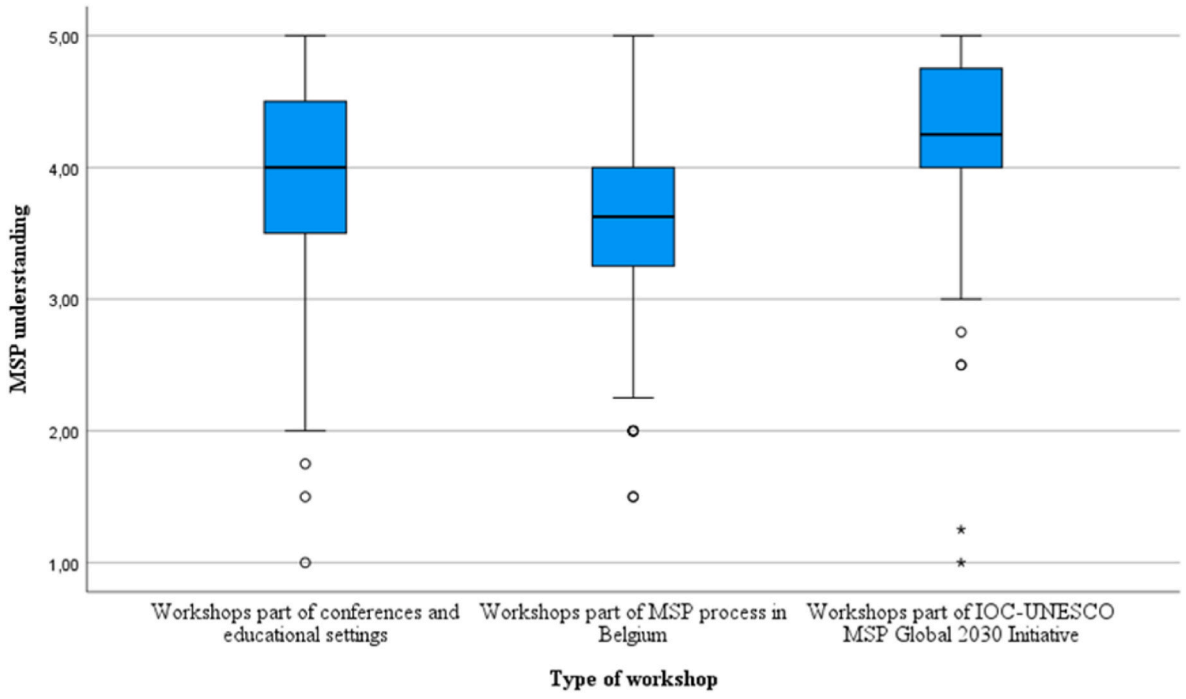

Fig. 3. Variations in MSP understanding by type of MSP Challenge board game workshop. Note: MSP understanding is a construct based upon 4 statements regarding learning in MSP. The dark centre line denotes the median value (50th percentile), while the blue box contains the 25th to 75th percentiles of the dataset. The light black whiskers mark the 5th and 95th percentages, and values beyond these upper and lower bounds are considered outlines. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

materials, such as introducing money and unique events (like hurricanes or coral bleaching). In other instances, the board game is supplemented with complementary activities, including presentations or lectures.

Through various channels, the MSP Challenge board game has found its way to conferences, educational institutions, and MSP authorities. Participants who encounter the board game for the first time, regularly approach the facilitators with all kinds of questions, such as: What is it? How does it work? Who is it intended for? Etc. Some participants expressed interest in borrowing or acquiring customized versions of the game, leading to the creation of over 50 copies for various organizations. A lightweight travel version developed for the IOC-UNESCO MSP Global 2030 initiative and translated into various languages has expanded the game's global reach.

To date, more than 96 workshops with over 2000 participants have been conducted, serving different purposes. These include workshops at conferences and in educational settings, workshops part of national MSP planning processes (such as in Belgium and Scotland), and capacity-building workshops as part of the MSP Global 2030 Initiative led by IOC-UNESCO and the European Commission's DG MARE.

4.1.2. *Learning from the MSP Challenge board game*

We have analyzed 51 MSP Challenge board game workshops conducted in various settings. Figs. 3 and 4 illustrate the variability in learning outcomes and participant experiences based on 935 completed questionnaires (results per workshop are detailed in the Annex). Fig. 3 shows that particularly the MSP Global workshops scored high on 'MSP understanding', while the workshops as part of the Belgium MSP process were relatively less informative for the participants. The board game is generally well-received, with participants expressing high satisfaction with the workshop format (see Fig. 4). Differences in 'MSP understanding' and 'Gameplay enjoyment' can be attributed, among other factors, to participants' varying backgrounds and experience levels in MSP as well as factors related to the workshop setup (e.g., facilitation, duration, number of participants (see also (Keijser et al., 2018)).

Comparing the results across workshops proves challenging due to significant variations in several aspects: the number of participants (ranging from 12 to over 30), workshop duration (from 1 to 3 h to multi-day events), participant types (planners, stakeholders, students, or mixed groups), and participants' experience levels (from none to highly experienced). Although it is difficult to account for all these variables, interviews and questionnaires suggest that the degree of learning may also be influenced by the game itself, the workshop design, the setting, and/or a combination of these factors.

Influence of the Object on Learning The physical nature of the board game forces participants to interact, which is less common in traditional workshops. As participants jointly have to develop a maritime spatial plan, they have to communicate, persuade, and negotiate with each other. These interactions encourage both individual and social learning. The board game sparks diverse discussions, such as on the question, "What is MSP?" Some see it as a formal, plan-based tool, others as a social process focused on learning and collaboration, and some emphasize the importance of data, which they feel is underrepresented in the game.

A workshop organizer noted that the board game's fictional sea and flexible design are key in fostering learning, especially social learning across boundaries. The fictional setting creates a level playing field, easing discussions by avoiding pre-established positions. The game's flexibility helps to create conflict situations and operationalize learning objectives, while assigning participants different roles fosters empathy and understanding. Another organizer highlighted the game's potential for "incremental" learning, allowing participants to build up knowledge by gradually increasing difficulty or by playing the game multiple times with the same group.

Participants expressed their appreciation for the game's *"learning by doing"* approach, describing it as both enjoyable and informative, though at times confusing and chaotic. This is supported by high scores on the statements: 'I think the game is fun' (mean 4.44) and 'I enjoy playing the game' (mean 4.46). Many feel that the board game effectively captures the complexity of MSP, with one participant noting it as a "*Really interesting and innovative way of getting people to think about the*

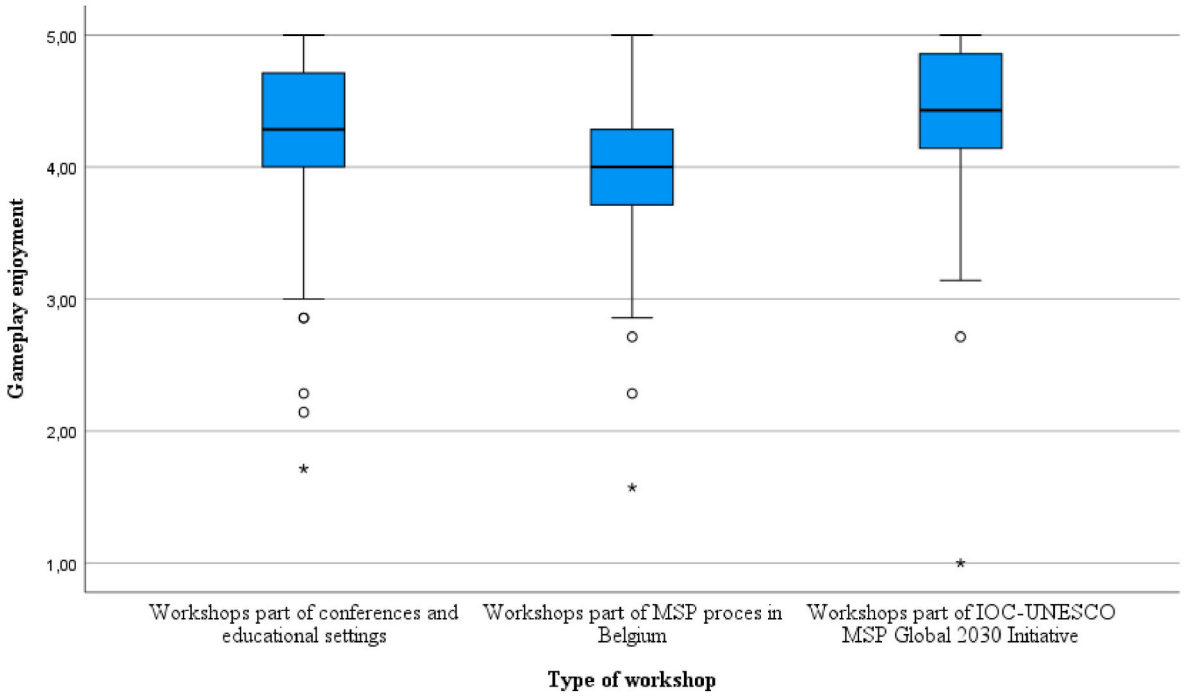

Fig. 4. Variations in gameplay enjoyment by type of MSP Challenge board game workshop. Note: Gameplay enjoyment is a construct based upon 7 statements. The dark centre line denotes the median value (50th percentile), while the blue box contains the 25th to 75th percentiles of the dataset. The light black whiskers mark the 5th and 95th percentages, and values beyond these upper and lower bounds are considered outlines. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

different interests and viewpoints of the various stakeholders" (participant Atlantic Strategy Stakeholder Conference workshop). Another participant wrote: *"The game offers a very fun and interesting way to understand MSP and should be made available to countries."* (participant of an MSP Global 2030 Initiative workshop).

However, some participants were more critical of certain aspects of the board game and provided remarks that indicated a lack of learning, mostly because they attributed their experience to flaws in the game design. For instance, some participants criticized the game for lacking detailed information, missing a budget component, and underemphasizing social issues. On average, participants rated the statement, 'The issues in the game represent the challenges in MSP,' as 4.14 out of 5. One participant from the ZMT workshop in Bremen, Germany, observed, *"The greatest downfall of the game, in my opinion, is that it undermines social issues. For instance, there are no cards for indigenous peoples, small-scale economies, small-scale fishermen, etc. In my experience, that is one of the greatest challenges of MSP."* Furthermore, some participants would have appreciated the game material and/or workshop to be held in their native language.

Influence of the Activity on Learning Various aspects related to the game activity, such as the number of players, the workshop's duration, and the quality of facilitation, appear to influence participants' learning experiences. One participant from the University of Ghent workshop noted that more people and time would have allowed for better discussion, as individuals were overwhelmed with managing multiple roles. Others expressed a desire to receive the rules in advance to play more effectively: *"I would have liked to see the rules ahead of time in order to play the game more effectively, especially given the short time frame in which to play"* (participant University of Ghent workshop). The quality of facilitation was also mentioned by a few participants, with some participants emphasizing that strong facilitation was key to the learning process, while others felt that certain facilitators were less effective. These differences are also visible with regard to the statement, 'I think the information provided in the game is clear.' The workshops as part of the Belgium MSP process scored significantly lower than the MSP Global workshops, while on average, participants agree with this statement. Furthermore, workshop organizers emphasized the importance of reflection in the learning process, noting that it plays a crucial role in how participants absorb and apply new insights. Observations show that intermediate and post-game reflections, often guided by facilitator feedback, help participants to refine their strategies. Despite this, the game often concludes with a chaotic 'Rica Sea', and many participants express that they would approach the game differently if given another chance. Some, like a participant from the MapSiS workshop, expressed that *"a deeper analysis of what happened after the game would be welcome."*

Influence of the Space on Learning The MSP Challenge board game has been played in various settings. Some organizers mentioned that using the board game within conferences or educational programs can enhance learning by making the theoretical aspects of MSP tangible. A participant from the MapSiS workshop in Las Palmas, Gran Canaria, noted, *"We played the game in the context of an MSP conference, so it was easier to engage with the game. It also enhanced our understanding and integration of the information from the conference"*.

The effectiveness of the workshop can vary depending on the setting and how well the activity is tailored to the audience. For instance, the analysis of the questionnaires shows that a 1.5-h board game workshop as part of the Belgian MSP process offered limited benefits for experienced participants, whereas longer, multi-day workshops, like those in the MSP Global 2030 Initiative, provided valuable insights for seasoned participants. This indicates that shorter workshops may be less effective for those with prior knowledge, while extended workshops with additional exercises can enhance learning. However, it is also important to note that the objectives of the workshop play a role; learning may not always be the primary goal. At times, the game is used to facilitate networking or serve as an engaging introduction activity.

4.1.3. Impact of the MSP Challenge board game

Although measuring the impact of using the board game is beyond the scope of this research, according to various workshop organizers, the game has led to noteworthy results. A workshop organizer mentioned that some capacity-building workshops as part of the IOC-UNESCO MSP Global 2030 Initiative have yielded tangible results, with insights from the game workshops being integrated into (policy) reports and plans. Another apparent learning effect is the increased recognition of the importance of stakeholder involvement. Some non-state participants noted that they better understood the role that they could take in an MSP process. This corresponds with the high score (mean = 4.23) of these MSP Global workshops on the statement 'I can really use some of the ideas and insights from the gaming exercise'. According to one person involved in the Scottish MSP process, the use of the MSP Challenge board game has helped stakeholders engage more effectively in discussions with policymakers. The adoption of the board game within the MSP community, including by former participants within their organizations, can be seen as a testament to its learning potential and practical value.

4.2. Results case study: MSP Challenge Simulation Platform

4.2.1. Description of MSP Challenge Simulation Platform

The MSP Challenge Simulation Platform, developed through various European projects, faced challenges due to differing views among project partners about the game's role in the project and its development direction. Some partners were satisfied with using an earlier, less realistic version, while others wanted more realism, including real GIS data and simulation models. As a result, developing the MSP Challenge Simulation Platform demanded considerably more effort, time, and resources compared to the board game.

Currently, the MSP Challenge Simulation Platform includes four editions—North Sea, Baltic Sea, Clyde, and Adriatic Sea—utilizing GIS data on human activities at sea and the physical state of the marine environment from national data centers and the EMODnet portal. Participants are responsible for developing a maritime spatial plan for their specific sea area, with new plans continuously simulated through a shipping model (de Groot et al., 2019), an energy model (Hutchinson et al., 2018), and an ecology model (Steenbeek et al., 2020). Participants receive constant feedback in the form of indicators and heatmaps, which provide them insights into the effects of short-term planning decisions. This allows participants to zoom in and out between their own sea area and the entire basin and also encourages them to provide feedback on each other's plans (see also Fig. 5). Additionally, a separate AR/VR application provides participants with insights into life at sea (Abspoel et al., 2021).

The MSP Challenge Simulation Platform is mainly played in a physical setting, but since 2021, it has also been possible to organize online workshops. Although individual play is possible, participants work mostly in-country teams, taking up the role of planners. Workshops typically follow a multi-phase approach: 1) introducing the game, explaining the software, and developing objectives; 2) translating objectives into concrete (national) plans; 3) international cooperation and coordination; 4) simulating and analyzing the plans, and if there is time left, the earlier phases are repeated; and 5) plenary feedback session. However, the game can also be applied differently. In the EU Interreg BalticLINes project, for example, the MSP Challenge Simulation Platform was used as a 'discussion tool' rather than for a 'game-play' workshop, with ICT experts handling system adjustments instead of participants.

The MSP Challenge Simulation Platform has also been applied in various settings, including at conferences, in universities' bachelor and master programs, and in EU projects such as EU Interreg NorthSEE and BalticLINES, to enhance understanding of transnational challenges (Lukic et al., 2020). Furthermore, in newly initiated projects like EcoScope and OR ELSE, new applications and models—such as a fisheries

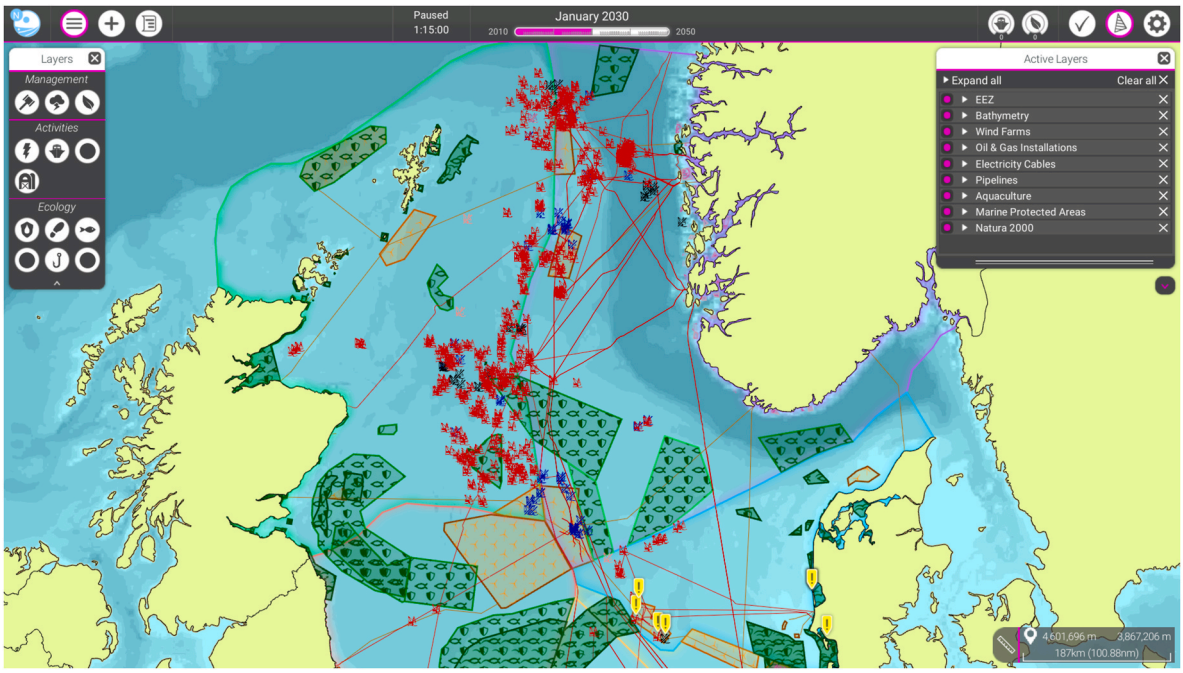

Fig. 5. Print screen of MSP Challenge Simulation Platform software.

module and a sand extraction module—are being developed to expand the platform's capabilities. However, its adoption in national MSP processes remains limited, partly due to the completion of plans before the platform was fully developed, software compatibility issues, and preferences for existing tools among some policy officers.

4.2.2. *Learning from the MSP Challenge Simulation Platform*

We have analyzed 11 MSP Challenge Simulation Platform workshops with a total of approximately 211 participants. These workshops were conducted in diverse settings: 5 workshop sessions as part of the EU Interreg NorthSEE project, 5 workshops as part of university bachelor and master programs, and 1 workshop at the Ecopath with Ecosim conference. The results from these workshops reveal variations in the extent of learning about MSP (see Fig. 6) and gameplay enjoyment (see Fig. 7). The Ecopath with Ecosim Conference workshop stands out with relatively high scores for 'MSP understanding' and 'Gameplay Enjoyment,' especially compared to the NorthSEE workshops. However, it should be noted that the MSP Challenge Simulation Platform was still in

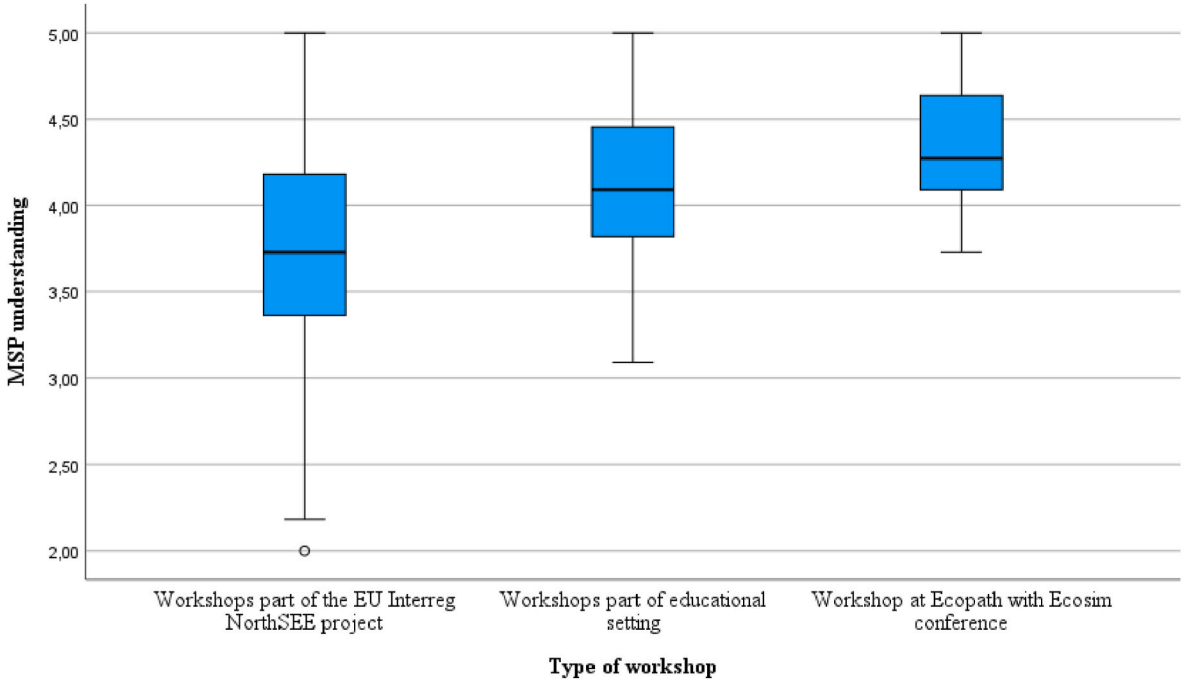

Fig. 6. Variations in MSP understanding by type of MSP Challenge Simulation Platform workshop. Note: MSP understanding is a construct based upon 11 statements regarding learning in MSP. The dark centre line denotes the median value (50th percentile), while the blue box contains the 25th to 75th percentiles of the dataset. The light black whiskers mark the 5th and 95th percentages, and values beyond these upper and lower bounds are considered outlines. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

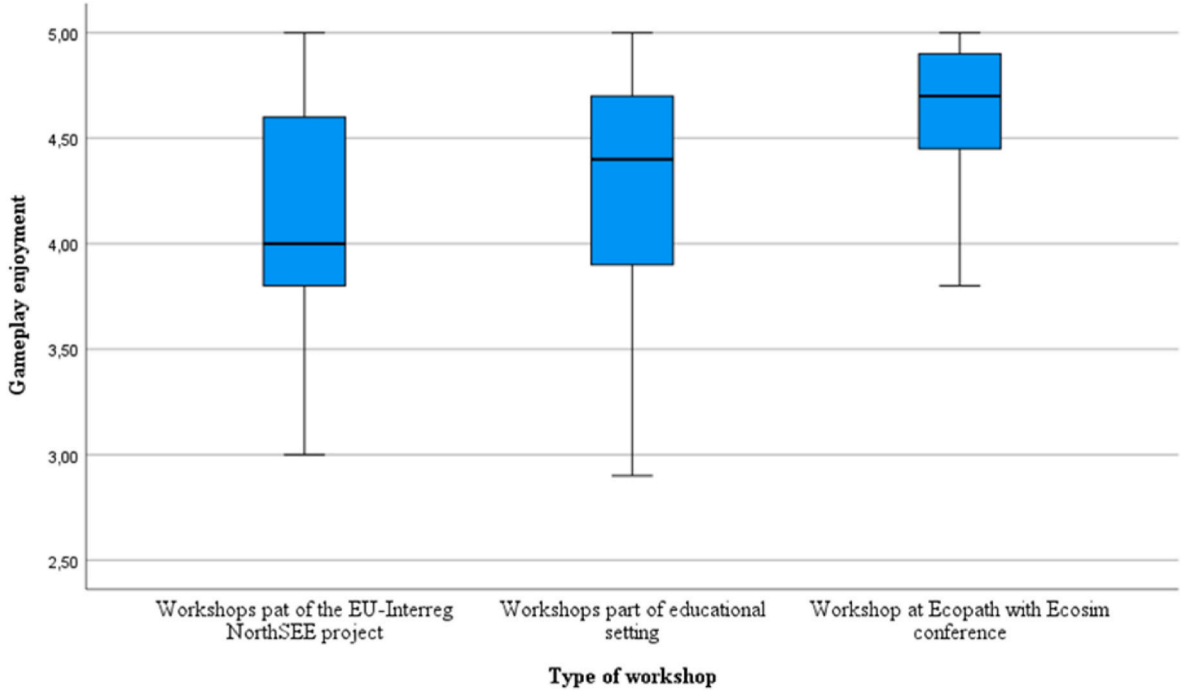

Fig. 7. Variations in gameplay enjoyment by type of MSP Challenge Simulation Platform workshop. Note: Gameplay enjoyment is a construct based upon 10 statements. The dark centre line denotes the median value (50th percentile), while the blue box contains the 25th to 75th percentiles of the dataset. The light black whiskers mark the 5th and 95th percentages, and values beyond these upper and lower bounds are considered outlines. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

development during the NorthSEE project, which makes these workshops less representative. The workshops, as part of an educational setting, score also high on both aspects. Comparing these workshops is challenging for similar reasons as those observed with the board game. The degree of learning is influenced by multiple factors, including the interaction between the platform, the activity, and the specific setting of each workshop, as described below.

The Influence of the Object on Learning In the MSP Challenge Simulation Platform, participants are encouraged to communicate, persuade, and negotiate, similar to the board game. However, team interactions may be more limited as participants primarily work behind computer screens within their country teams. According to some workshop organizers, the advantage of the MSP Challenge Simulation Platform, compared to the board game, is that it provides participants with insights into their decisions through indicators and heatmaps. This feedback emphasizes the importance of future-proof planning and international collaboration and contributes to participants' learning experiences. Many participants also found the gaming exercise enjoyable, which is reflected not only in Fig. 7 but also in the post-game questionnaires. Participants vividly remember the workshop 6–9 months later and found it fun (see Table 4 in the Annex).

In questionnaires and interviews, participants highlighted the platform's ability to make the complexity of MSP both visual and tangible as highly valuable. A participant of a NorthSEE workshop mentioned: *"Very intuitive and interactive way to think about the concept of marine planning."* A workshop participant of the NorthSEE Shipping workshop stated, "*It is not a theoretical presentation about what MSP is; it is a practical/visual presentation of MSP. It can help new people to let them understand what MSP is about. It helps in raising awareness about MSP and in getting a better understanding of MSP*." Participants also appreciated gaining insight into how short-term decisions in one country can have (unintended) consequences in other countries, with some effects only becoming apparent over time. Many participants also found it beneficial to focus on the entire North Sea rather than just one country: *"What I found educational and insightful is that the entire North Sea is used as a basin—not just the Dutch part of the North Sea, but the whole North Sea"* (participant NorthSEE Connecting Seas workshop).

Similar to the board game, several participants noted flaws in the game design, which may have impacted their learning experience. Some participants mentioned that the ecological data (e.g., on birds) was not detailed enough to base decisions on, while others expressed a desire for AIS data or the inclusion of larger, high-capacity energy cables. This might also explain the differences in results with regard to the statements 'The simulation was sufficiently realistic' and 'The issues in the game represent the challenges in MSP accordingly.' Some participants wanted more insight into the underlying models, while others wished for shortcuts when plotting cables, as the current process was time-consuming.

Additionally, some participants found the software complicated to use, and based on the analysis of the questionnaires, those who were more comfortable with new computer applications tended to enjoy the game more. However, many participants also reported becoming more proficient with the system over time, as one participant noted: *"Many of the challenges in handling/working with the tool would be easy to resolve by having a longer session"* (participant NorthSEE shipping workshop). This is also reflected in the results of the statement, 'As the game progressed, it became easier to navigate in the game' (see Table 3 in Annex).

The Influence of the Activity on Learning Like the board game, the MSP Challenge Simulation Platform has been implemented in various formats, ranging from two half-day sessions to full-day and even multi-day workshops. Similar to the board game, the learning experience is influenced by various factors, such as the number and type of participants, the duration of the workshop, the facilitator's role, and the set-up of the workshop. The length of the workshop often depended on the context in which the workshops were held; multi-day workshops were typically conducted in educational settings, while stakeholder workshops were mainly 2x half a day or a full day. Several participants mentioned that the sessions were often too short, especially considering the time needed to become familiar with the software. The role of the instructors, however, was generally very positive in all the workshops,

with scores averaging between agree and strongly agree.

In some stakeholder workshops, including one held as part of the NorthSEE project, there were significant differences in participants' experience levels. For some, MSP was entirely new, while others were highly experienced. This disparity made the platform too complex for some participants, creating a steep learning curve. As a result, certain discussions were less effective, and not everyone fully embraced their role. This is also evident in the results of specific statements, such as, 'Other players (team members) played their roles well.' In the NorthSEE ecology workshop, this statement scored an average of 3.63, which is lower than in other workshops. A NorthSEE ecology workshop participant noted, *"I found the MSP game session a bit chaotic, with participants occasionally completely lost in the software or unsure about their role in the planning process."* In a follow-up workshop, the format was adjusted from one full day of gameplay to two half-days, incorporating the board game as well. This change was well-received: *"Interesting session with a computer-simulated game after a first 'evening session' with the board game, which was a perfect introduction to the online game"* (participant from the NorthSEE Energy workshop).

The Influence of the Space on Learning The MSP Challenge Simulation Platform has been utilized in stakeholder workshops as part of EU projects, in educational settings, and at conferences. When the game is integrated into teaching modules that span several days to a week (see also (Behrendt et al., 2021), the MSP Challenge Simulation Platform is often combined with other educational activities, such as lectures and readings on various MSP aspects, allowing participants to apply their learning during the game. According to one of the workshop organizers, this approach works effectively.

In other contexts, depending on the specific objectives and audience of the workshop, it may be more effective to use the game differently (e.g., as a discussion tool). Moreover, it is important to frame the workshop well, especially when playing the game with real stakeholders. For instance, in a particular situation, a participant left because he/she felt unprepared for the experience. He/she was not prepared to play the game with real stakeholders, using real GIS data, and discussing real issues. Hence, in some workshops, the MSP Challenge Simulation Platform was viewed less as a serious game and more as a decision-support tool.

Additionally, in some contexts, it may be beneficial to invite independent experts on specific topics. For example, having experts on specific topics present, such as food web model developers, can enhance participants' understanding of the workshop outcomes. During the NorthSEE Ecology workshop, the developers of the food web model explained how fishing influences the food web, leading to moderate to radical changes in participants' strategies for fishing efforts. This also demonstrates that intermediate discussions and reflection are crucial for learning.

4.2.3. Impact of the MSP Challenge Simulation Platform

To what extent the MSP Challenge Simulation Platform has led to organizational or policy learning cannot be determined based on this research. However, multiple respondents indicated in post-game questionnaires that they would recommend the game to colleagues and their stakeholder networks. About 75% of the respondents to the post-post-game questionnaire indicated that they shared their experiences with direct colleagues. This dissemination of insights helps integrate the game's findings into a broader social context. For some workshops, particularly those linked to the EU projects, reports were generated and the results were utilized within these projects. Various participants provided further suggestions to play the game with real stakeholders and planners, and use it in international workshops.

Additionally, many respondents, policymakers, and stakeholders recognize the clear potential of the MSP Challenge in supporting the development and implementation of a maritime spatial plan. A workshop participant of the Aberdeen workshop mentioned in the post-post game survey: "*I think it cannot do without. It's the perfect tool to identify plans, ambitions, activities, and consequences in a transnational way*." However, a participant of the Connecting Seas workshop views the potential primarily as a training tool: "*I don't see it as a tool that helps the plan itself, but it helps to train the people that are responsible for the plan and/or are involved in the planning process. And particularly if they are (still) unexperienced*".

The degree to which participants have been able to apply insights from the MSP Challenge workshop in their daily work varies significantly from individual to individual, as indicated by the high standard deviations in the responses (see Table 4 in the Annex). Some respondents mentioned in the post-post-game questionnaire that they haven't utilized the insights in their everyday tasks for various reasons, such as not being involved with the topic in real life or already possessing substantial knowledge on the subject. One participant mentioned introducing serious gaming as a concept in their office, while another participant didn't learn anything content-wise but learned more about stakeholder management and the way of working, applying this knowledge to a different topic in their country: *"The understanding that you have to put in a lot more time. It does make the process seem to take longer, but you get a better understanding of the interests and so on"* (participant NorthSEE Energy workshop).

5. Discussion

The MSP Challenge serious games function as boundary objects by uniting participants from diverse backgrounds and facilitating knowledge exchange across disciplinary boundaries. While the game's rules and frameworks are standardized, participants bring their own expertise and perspectives, collectively developing a more comprehensive understanding of MSP without necessarily reaching a consensus. The learning process is supported by the distinct features of the MSP Challenge serious games. The board game offers a shared playing field, incorporates ambiguity (such as undefined country boundaries), and is flexible in use. It allows participants to assume various roles, fostering empathy and insight into other stakeholders' positions. Conversely, the MSP Challenge Simulation Platform provides real-life feedback by processing participants' plans through sector-specific simulation models and emphasizing the importance of international collaboration. However, while the board game promotes intuitive interactions, the simulation platform's computer-based interface can hinder communication and learning. The computer software can be an additional barrier for participants to exchange information and learn from each other, as some participants have indicated that they find the software complicated and that drawing plans into the system takes up valuable discussion time. This suggests that an object can serve as a boundary object in one setting but act as a barrier in another, as noted by (Bechky, 2003) and (Clarke, 2021). This variability demonstrates that learning outcomes are influenced by the interaction between the object and the activity within a given context.

Using the boundary space framework, we found that the degree of learning depends on the object's alignment with the activity and the setting. In some instances, deficiencies in the object (e.g., missing data or information) impacted learning, while in others, the design of the activity (e.g., inadequate explanations or time constraints) influenced the learning potential, and in yet other cases, it was a combination of factors. The setting also plays a crucial role in determining the optimal use of the object and activity. For example, in a setting with real stakeholders and planners, allocating more time for discussion and using the game to facilitate these discussions, rather than focusing on role-playing or computer tasks, may be more effective. In educational settings with less experienced students, combining role-playing with GIS skills development through computer-based simulations can be highly instructive. In such cases, the MSP Challenge board game can serve as an introduction to MSP, while the MSP Challenge Simulation Platform can be used for advanced learning. These observations align with Morris et al. (2021), who emphasize the importance of the object's functionality, the appropriateness of the activity, and their fit within the context

(Morris et al., 2021), as well as Star, who notes that the context in which a boundary object is embedded determines its effectiveness (Star, 2010).

Nevertheless, the efficacy of a boundary object is not always predictable, as it acquires a unique identity upon deployment, and its use and further development can be unpredictable (Morris et al., 2021). Star, 2010 also argues that purposefully designed boundary objects can fail due to insufficient ambiguity (Star, 2010). The MSP Challenge games are "boundary-objects-by design", but seem to be inherently flexible and dynamic as they are used in different ways and for different purposes. While the MSP Challenge serious games have been developed by a small team with a specific purpose in mind, the MSP Challenge serious games have undergone continuous evolution, including the addition of new features based on user feedback and the creation of new simulation modules in recent EU projects. This aligns with Klein and Kleinman (2002), who argue that the development of an object involves multiple groups with differing views and in which different groups probably arrive at very different objects (Klein and Kleinman, 2002), and with Bijker (1995), who suggest that the design process does not end based on the objective functionality of the artifact but when social groups recognize the object's effectiveness for their needs (Bijker, 1995). This perspective also relates to discussions on authorship and power dynamics, which can influence the object's use and learning potential. Some workshop participants noted missing elements, such as social aspects like small-scale economies and indigenous peoples, while others wanted more focus on fisheries or specific indicators related to the simulation platform. These gaps may be attributed to the context of the game's development and project objectives, which prioritized shipping, energy, and ecology over fisheries.

The extent to which organizational and policy learning occurs as a result of the MSP Challenge is difficult to assess, as it may depend on various factors, including participants' roles within their organizations and whether the knowledge gained is effectively shared and internalized by others within those organizations (Vinke-de Kruijf et al., 2020). While some participants indicated that they shared their experiences with colleagues, it is not possible to draw conclusions about the extent to which their gaming experience led to organizational learning and whether this contributed to the effective and legitimate development and implementation of policies. However, the specific characteristics of the serious games, as boundary objects and the related activities and context, made learning processes more memorable and more explicit. This is already an important step, following Armitage et al. (2008), as it is important not just to assume that learning takes place, but to be conscious of it and have realistic expectations (see also (Keijser et al., 2020).

6. Conclusion

The MSP Challenge serious games were developed to enhance international learning in ecosystem-based MSP and have been utilized in diverse ways and settings since their introduction. Our findings show that the MSP Challenge, as a boundary object, effectively facilitates both individual and social learning in MSP by bringing together participants with diverse backgrounds. The fictional nature and flexibility of the MSP Challenge board game foster interaction among participants, while the feedback mechanisms of the MSP Challenge Simulation Platform provide valuable insights into the complexity and long-term consequences of short-term decisions by making these outcomes visible.

The extent to which the MSP Challenge contributes to individual and social learning depends on the boundary space in which it is applied. Beyond individual participant characteristics like experience and background, learning outcomes are influenced by the features of the object, the design of the activity, and the context in which the game is employed. While some participants find certain game features to enhance learning, other factors—such as missing data, relevant MSP aspects, or system complexity—can hinder learning. The design of the activity is equally important. Our findings highlight the importance of allocating sufficient time for workshops, providing effective facilitation, tailoring the workshop to the number and type of participants, and incorporating ample time for reflection. An interesting venue for research is, therefore, to explore the perspectives and decisions of game designers on the development of the tool. Additionally, in certain settings, such as educational workshops, it can be beneficial to combine the MSP Challenge serious games with complementary tools, such as lectures. In other contexts, it may be more effective to use the tool differently (e.g., as a discussion tool), depending on the specific objectives and audience of the workshop. The boundary space framework, as presented in this paper, can serve as a descriptive-analytic tool to capture lessons on the relevance, benefits, and challenges of using (combined) tools.

While this research did not investigate the extent to which individual and social learning from the MSP Challenge translated into organizational or policy learning, several participants reported sharing their experiences with colleagues and external contacts. Additionally, the MSP Challenge serious games, particularly the board game, have been adopted by various MSP authorities for training and stakeholder engagement. For these serious games to effectively contribute to policy learning, it is crucial to ensure their representativeness, usability, and participant diversity. Equally important is the integration of workshop insights into organizational, network, and political processes. Further research is needed to explore these aspects.

CRediT authorship contribution statement

Xander Keijser: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Conceptualization. **Hilde Toonen:** Writing – review & editing, Supervision, Conceptualization. **Igor Mayer:** Writing – review & editing, Supervision, Conceptualization. **Jan P.M. van Tatenhove:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ocecoaman.2025.107590.

Data availability

Data will be made available on request.

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