Maritime Spatial Planning and Integrated Coastal Zone Management in Higher Education: Utilizing the MSP Challenge Serious Game

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Abstract: Digitalization is gaining increasing attention in Higher Education (HE). The integration of digital tools into instructional settings is particularly challenging, However, it offers many opportunities to improve the learning process of students, especially in interdisciplinary teaching scenarios such as teaching sustainable usage of space and resources i.e. for the coastal zones and the marine areas. Worldwide, Marine Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM) are much needed approaches to manage and organize the increasing use of the sea and coastal areas. Both are complex fields that are attracting more and more attention in interdisciplinary HE. Correspondingly designed, the module 'Planning and Management of Coastal Zones and Sea Basins' at the University of Oldenburg, Germany, provides a case for integrating digital tools into HE. In 2020, the digital serious game 'MSP Challenge´ was used in an online learning format. This interactive and collaborative tool supports informed decision making based on real and simulated data, comparable to business (decision) processes based on environmental information systems (EIS). Therefore, the MSP Challenge game fosters not only the understanding of the complex topic but additionally methodological skills which can be transferred to the usage EIS. While playing, students become able to (1) evaluate and simulate impacts of uses on coastal and marine environments, (2) describe the main interactions in ecosystems, (3) conceptualize information for sectoral or integrated MSP and (4) reflect on the role and use of data. In the presented case master students studying "Water and Coastal Management" participated in the module. Moreover, the digital serious game and the interdisciplinary topics of MSP and ICZM provides additional opportunities to explore subtopics (e.g. IT-related) from other disciplinary perspectives.

Keywords: Higher Education, Innovation, Serious Gaming, Maritime Spatial Planning, Integrated Coastal Zone Management.

1 Introduction

Digitalization is gaining increasing attention in Higher Education (HE). Different aspects are considered in digitalization strategies of HE institutions, mainly to foster digital skills of future professionals. The integration of digital tools into instructional settings is particularly challenging but it implies many opportunities to improve the learning process of students especially in interdisciplinary teaching settings such as teaching sustainable usage of space and resources, i.e. of coastal zones and marine areas.

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European seas, and especially the North Sea and Baltic Sea belong to the busiest seas for maritime industries worldwide [Ha08]. Their shared resources represent a crucial asset but also a mutual territorial challenge to European countries. Also, coastal zones show high socio-economic activity with high vulnerability (especially to climate change) and a continuously changing environment. Marine Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM) are much needed approaches to manage and organize the use of the sea and coastal areas to prevent uncoordinated planning and management. Both coastal zones and marine areas are complex systems with an important ecology, as well as numerous human uses and activities. Various challenges arise from local to national to international levels. MSP and ICZM are complex fields of societal action. Accordingly, they constitute interdisciplinary fields of study with significantly overlapping important topics with respect to theoretical concepts, disciplinary approaches and problem-driven interdisciplinary integration in HE. Students in their future careers will encounter complex issues (such as sustainable development of marine and coastal environments) and must be able to make informed decisions.

Even though it is also an already legally binding mechanism within the EU, MSP is still relatively new and has no classical textbook for knowledge transfer. Educational innovations and trials are therefore of enormous importance to communicate current research and challenges of the sectors involved in both MSP and ICZM.

Serious/simulation games (SG) can be used to facilitate student engagement, provide opportunities to deepen mutual understanding, and explore and integrate new ideas and solutions, also for water, sea and ocean issues [Me20]. SG are collaborative tools that make use of the technologies of games and the principles of play to achieve objectives that are valued not for their intrinsic value (i.e., merely for the sake of entertainment) but for the extrinsic value achieved by the consequences, such as the fact that engagement and feedback in play is a good condition for learning and change [Ma16].

In this paper the goal is to address the challenges related to MSP and ICZM education through interdisciplinary teaching with an innovative SG approach. In other words, the goal is to integrate a SG within a MSP and ICZM module efficiently and effectively, i.e., making use of the different SG features to encourage a MSP and ICZM learning process. The SG will be evaluated concerning its relevance to the intended learning outcomes of a MSP/ICZM-HE module.

2 Methods and Educational Setting

SGs offers novel opportunities for problem-based interdisciplinary education for mutual understanding, exchange of ideas, development of new approaches and understanding the complexity of different activities. SGs are of particular value in teaching because the direct interaction of students and teachers with the subject matter is carried out through trial and error, practically and interactively. As such playing a SG is a form of collaborative discovery learning.

2.1 MSP Challenge

Since 2011, under the name ‚MSP Challenge‘ different SGs in support of MSP have been developed and applied, i.e., for education, social learning, stakeholder engagement and decision-support [Ab19], [Ke18], [Ma14]. MSP Challenge is an interactive and collaborative tool for informed decision making to experience the complexity of possible actions of marine planning and coastal management based on real data. It combines role-play, game technology, geodata and simulation models to offer a planning-oriented learning tool for MSP and a communicative environment that makes players think, talk and interact.

The MSP Challenge Simulation Platform was developed to further support the development of digital SGs concerning particular sea basins [Sa20]. The simulation platform allows players to creatively operate it for scenario development, and/or for multi-player SG sessions. This means that the platform supports multiple purposes such as planning scenario exploration, co-design, validation or policy-oriented learning [Ab19]. The simulation platform helps users or players to reflect on their individual and combined decisions using real geodata and simulation models for energy production, shipping and environment.

MSP Challenge communicates through Open Geospatial Consortium standards to obtain geodata relevant to the edition at hand. For the North Sea edition this means using WMS hosted by a GeoServer installation to obtain both vector and raster data from several different sources, notably EMODnet Human Activities, Copernicus Marine Service and bespoke sources (full list on https://community.mspchallenge.info/wiki/Data_sources). Subsequently, MSP Challenge uses much of this data as well as data created by the users/players themselves for energy, shipping and marine ecosystem simulations. In turn these simulations create new and altered raster layers and key performance indicators (KPI). The ecosystem simulation communicates with a Ecopath-with-Ecosim model specific to the sea basin at hand [St20]. The shipping and [Gr19] energy [Hu18] simulations are bespoke applications.

In the North Sea Edition up to 8 countries can be played with 2-6 players per country. The players are confronted with the general goal of developing the EEZ of the country they represent considering e.g. „Blue Growth“ and „Sustainability“. The exact interpretation and implementation of this goal is subsequently of course up to the players to discover as they play. The interaction and effects between human activities, geosystem and ecosystem are simulated (incl. Feedback loops) and visualized using heat maps and indicators.

2.2 MSP / ICZM Higher Education Module

The module ‘Planning and Management of Coastal Zones and Sea Basins’ is an established master course at the Carl von Ossietzky University of Oldenburg, Germany. It consists of two lectures “Marine Spatial Planning” and “Integrated Coastal Zone Management”. Within the module, a heterogeneous group with students from all over the world with an interdisciplinary background - learns together. Adding to the variety of previous knowledge and experiences, the current studies of the students vary as well: the module is elective within certain master programs focusing on natural science, economics or management. The module covers the complex interrelations between the natural marine and coastal spaces on the one hand, and human activities on the other.

The main goal of module is to enable students to develop a theoretical, practical and critical understanding of the notion of MSP and ICZM and the wider scientific and governance framework in which it is being implemented.

2.3 Methodological-didactical concept

The two lectures are generally separated lecture series (separated ICZM and MSP issues) with a significant overlap in the intended skills. As an innovative approach of the module, the two lectures have been linked via the MSP Challenge SG. The learning process and experiences of the gaming events were reported and reflected by the students on the associated Wordpress blog and in their final report (final assignment).

To ensure a significant learning impact of the SG, the following considerations contributed to the final time structure of the module. First, before the SG started, an overview of the topics needed to be given in which important terms would be clarified. Second, students needed an introduction to the SG involving a synchronous tutorial with asynchronous self-learning task. Third, students needed to be able to share their ideas, strategies and conclusions for the SG with the whole group. Based on their reflection, new or adjusted strategies could then be developed and applied in the next SG session.

The SG experience was one of the cornerstones of the module. Therefore, in the middle of the lecture series two SG days have been scheduled. The SG was designed as a role-play: the players represented different stakeholders of five European Countries along the North Sea. They received the task to develop their country along personal priorities keeping the EU policy concerning Blue Growth, Renewable Energy and Environmental Protection in mind. As the whole module was realized in an online setting, different virtual meeting rooms (main room, group rooms, additional virtual meeting rooms) have been prepared for communication, discussion and debriefing. The main room was used to meet with the whole group at the beginning and in the middle of the day for guidance and clarifying open questions and at the end of the day for a joint evaluation of the resulting plans and simulations.

3 Results

To achieve the goals of the module and to develop an adequate instructional design, intended competences and learning outcomes for the students were defined and the impact of the different learning activities (lectures, gaming, wordpress, final report) on the learning outcomes has been evaluated.

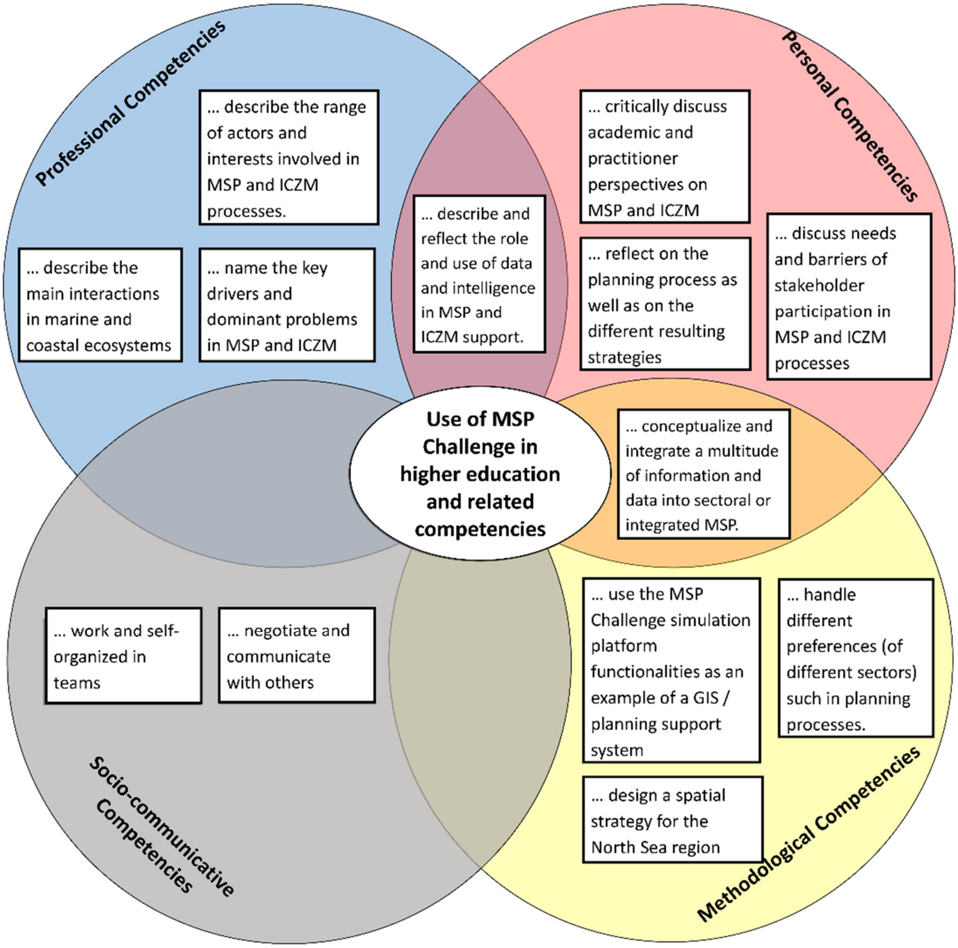

Fig. 1: Learning outcomes of the module "Planning and Management of Coastal Zones and Sea Basins" addressed by the MSP Challenge game depending on different competence areas: professional competencies (blue), personal (red), methodological (yellow) and socio-communicative competencies (grey) and the interfaces between personal and professional competencies (violet) and personal and methodological competencies (orange).

Among 21 different competences and skills that the students shall gain during the module, thirteen learning outcomes have been identified to be supported by the MSP Challenge SG (with varying intensity). Fig. 1 shows these learning outcomes. To receive a detailed impression of the impact, the competences are distinguished into the competence areas professional, personal, socio-communicative and methodological competencies. The use of the MSP Challenge SG in the module addresses different learning outcomes within all four competence areas. A specifically high impact is anticipated for the development of personal, social-communicative and methodological competencies. While using the SG, students learn to evaluate and simulate impacts of uses on coastal and marine environments. This requires to (a) describe the main interactions in ecosystems, (b) conceptualize information for sectoral or integrated MSP and (c) reflect on the role and use of data (simulation, models, AI).

Concerning the improvement of the learning process for an efficient integration of the SG into the HE module, the impact of the SG approach is evaluated in more detail: the different learning outcomes are attributed to the different features included in the MSP Challenge SG software and the SG play process. The main features are summarized in Tab.1 and 2 and their attribution to the intended learning outcomes are given in Tab. 3.

The features delivered by the MSP Challenge game are distinguished between „mechanical features“ and “dynamical features”. Mechanical features are structurally included in the SG software. These features are the basis for the application of the SG in an educating setting. The players work with a map of the North Sea including important information as different layers. They are organized (logged in) as groups related to their countries, able to draw plans for their EEZ, able to communicate with other countries, and receive automatic feedback (i.e. restrictions or requirements). Based on the created plans, the simulations calculate their impact on the different data layers. The simulations can be started, accelerated or stopped by the teacher depending on the didactical need. The simulation results are visualized in terms of pressures and indicators in maps and diagrams. The time view control allows to go back and forth in time to evaluate the evolution of a specific dataset.

Dynamical features are those introduced by the SG play process due to interactions between different mechanical features or different players, or through intervention, support or tasks by the teacher. An important aspect in the SG play process is the role play. Each player has a different responsibility for his/her country with a goal for the considered sector (based also on the knowledge gained during the lectures). Every player is able to create a plan (e.g. to declare an environmental protection area) giving it also an implementation date facing the lack of time and space. A multitude of data and maps can be evaluated for making decisions. This includes learning about the management of data with certain hurdles as lack of data, different scales in time and space, incorrect, incomplete and unavailable data which is also discussed within the whole group. By communicating with other group members and with other groups (i.e. included approval system) a consensus has to be reached.

The role of the teacher and the forum discussions (course concept) to intensify the impact of the dynamical features is crucial. In break-out moments and debriefing sessions throughout the whole gaming process the students are guided. Within these joint sessions results are shown and evaluated, interactions and impacts are highlighted (including the limitations of simulations concerning the considered mechanism) and reasoning of the different individual decisions are discussed. A good time management to balance the need of time for planning and the need for guided reflection is crucial at this point. Improving the communication between the players could save time and enhance the outcome, for example by playing the game face-to-face or giving more guidance on communication paths.

Mechanics			
Simulations	**Visualization**	**Tools**	**Organization**
ecology, shipping, energy models	real data/ simulated data	planning tool for planning process	team organization
running simulation (incl. speeding up/pause)	maps with different layers	time based planning and simulation	approval system
simulation results	Time view control	drawing feature (points, lines, shapes/polygons)	communication option in approval system
limitations (e.g. resolution, considered mechanisms)	Key Performance Indicator (KPI)	knowledge base/wiki	restrictions and feedback mechanism
	pressures		

Tab. 1: Mechanical features introduced by the MSP Challenge game.

Dynamics		
Role Play	**SG play Process**	**Course Concept**
players representing role	predefined objectives / goals	support of players by teacher
proactively discussing	management of data	apply knowledge gained in lectures
teachers as legislative international actor	mapping	"break-out"-moments;
barriers as lack of time and space	evaluation of available information	debriefing
group of 2-3 students	strategy development	evaluation process
	Personal priorities	

Tab. 2: Dynamical features introduced by the MSP Challenge game.

Learning Outcome	**Mechanical Features**	**Dynamical Features**
…describe the range of actors and interests involved in MSP and ICZM processes.	different layers (management, activities, ecology), knowledge base; restriction feedback mechanism	role play (player representing role); defined objectives/goals
…describe the main interactions in marine and coastal ecosystems	i.e. marine ecosystems: simulation, maps, KPI, time view control (evolution during time)	role play (proactiveley discussing),
…name the key drivers and legal context in Europe	knowledge base / wiki; layers; approval system;	predefined objectives (country specific)/goals (EU policy); role play
…to describe and reflect on the role and use of data and intelligence in MSP and ICZM support.	MSP Challenge based on real data, simulations (incl. limitations, e.g. resolution, considered mechanisms)	management of data (different scales - time & space, incorrect, incomplete, contested, out-of-date and unavailable data)
…reflect on examples of land-sea interactions	pressures; ports; shipping and energy simulation / recreation	
…use the MSP Challenge simulation platform functionalities, as an example of a GIS / planning support system.	drawing feature (points, lines, shapes/polygons), time-based planning and simulation, real data and simulations, lack of relevant data	
…handle different preferences (i.e. sectors) in planning processes.	different data layers - non static layers that can be changed /simulations;	role play, support by teacher (i.e. synergies), gaming procedure: objectives that need to be reached;
…design a spatial strategy for the North Sea region	layers (existing situation), planning tool, approval system	SG task incl. defining objectives/ steps; evaluation of available information, mapping
…conceptualize and integrate a multitude of information and data into sectoral or integrated MSP	large amount of real-data and simulated data available in MSP Challenge, knowledge base	depending on personal/national strategies; apply knowledge gained in lectures; evaluate available data

…discuss needs and barriers of stakeholder participation in MSP and ICZM processes.	lack of time and space / speeding simulation up/pause; communication option in approval system	role play incl. barriers as lack of time and space
…reflect on the planning process as well as on the resulting strategies.	running simulation / results (immediately) visualized in different maps (time lapse); KPIs	"break-out"-moments; debriefing; evaluation process
…work and self-organize in teams, e.g., making role and task division and coordinate tasks	team organization / log in as team; possibility to take over others plan in the team	role play / group work: group of 2-3 students responsible for an EEZ of one European country
…negotiate/communicate with others (countries and stakeholders).	approvals by other countries; communication tab	role play (players representing different stakeholders); strategy development; personal priorities

Tab. 3: Attribution of MSP Challenge features to the intended learning outcomes of the higher education module. The colors indicate the different competence areas (see Fig.1).

4 Reflection

In terms of digitalization of Higher Education an example of a SG approach was presented. The applicability of the MSP Challenge simulation platform for MSP/ICZM education was evaluated in terms of its impact on the intended learning outcomes. Our initial evaluation shows a high potential for the SG approach in this setting. Overall, the module successfully utilized the ‘MSP Challenge’ SG to highlight the complex interrelation of coastal and maritime spaces for the benefit of interactive and interdisciplinary higher education. A limited impact of the game is seen for the reflection of land-sea-interaction. Further effects might be simulated (energy demand/supply interactions; agriculture pollution and other land uses) to increase the knowledge gain.

In the presented case master students studying “Water and Coastal Management” participated in the module. However, the classes are open to students from various backgrounds and disciplines, as the digital SG and the interdisciplinary topics of MSP and ICZM provides additional opportunities to explore subtopics from other disciplinary perspectives. With its inherent simulation and information tools it fosters not only the understanding of the complex topic but additionally methodological skills such as the collection and evaluation of relevant environmental data. Furthermore, multiple IT relevant components of the digital SG comprise opportunities to further develop, modify or adjust it (in terms of software development) in appropriate educational settings.

Further implementation of the SG approach needs a continuous evaluation to measure the learning progress supported by the game and to introduce further optimization. The associated evaluation of the progress in intended learning outcomes (rated by the students) remains to be analyzed.

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