

CSI-POM: EMPOWERING OCEAN LITERACY THROUGH MARINE RESEARCH AND MONITORING

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Abstract

In our Ocean Literacy activities, we applied two modern research systems, CSI-POM and its second stage, CSI-POM2, to involve, first teachers and then youth in educational activities. In this presentation we focus on a CSI-POM2 system. The CSI-POM2 system was designed to monitor and forecast the state of the southern Baltic environment and its changing environmental conditions, thereby providing a modern tool for effective environmental management in the Polish maritime economy and as well as for protecting people and the environment. Therefore, the primary purpose of the system is to provide scientific information and support decision making, while we used its features for educational activities. In late fall 2024, we had run two day-long, in-person workshops entitled: Using CSI-POM2 tools in modern ocean education. Both workshops gathered a total of 24 participants representing 18 various educational institutions, both formal and non-formal. Then, in late spring 2025, we run a webinar for school teachers, which gathered over 25 participants from different institutions. During these events, we discussed the opportunities and challenges facing the education in the context of using innovative tools such as those developed within the project. According to the SWOT analysis, based on the outcomes of the events, ease of use, free access, and interactive data presentations are the strengths of CSI-POM tools. Thus, they can very well support activities dedicated to increase of ecological awareness and in ocean educational activities. Therefore, we prepared educational packages, which we have been successfully using in educational activities since the beginning of 2026, with a total of over 90 educators who were introduced to the educational package of the system. During the presentation, we briefly show the system features and examples of lesson plans based on the system tools.

Keywords: *Ocean Literacy, environmental education, public engagement, oceanographic data, environmental monitoring.*

1. Introduction

The world ocean covers over 70% of our planet's surface and plays a key role in creating and mitigating climate, sustaining biodiversity, and providing means for supporting all life. Despite this crucial role, ocean is not very well understood and common knowledge about the ocean is still very limited and fragmented. The general level of ocean literacy, a concept that refers to an understanding of how the ocean functions within Earth's systems, how human activities affect marine ecosystems, and how individuals can make informed choices to protect ocean health, is still low.

Environmental adverse pressures, mainly related to climate change, marine pollution, and marine biodiversity loss continue to increase (e.g., O'Hara and Halpern 2022). Therefore, promoting ocean literacy is becoming real requirement for all parties, including those involved in marine research and monitoring, elements which may play a central to this effort. In order to connect people with the ocean, society needs scientific evidence, which supports deeper ocean ecosystem understanding and guide decision-making, hence foster greater awareness and responsibility toward the ocean (Kennedy 2026).

While we observe continuous changes in education of any form and the growing role of technology in teaching and learning, the concept of ocean literacy is directly embedded in the goals of the UN Ocean Decade, which puts stress on a shift from more old-fashioned, theoretical understanding to more participatory, active and responsible citizen. Thus, such approaches like systems thinking and interdisciplinary learning require modern curricula, which reach beyond individual subjects. Themes such as the ocean's influence on climate change, economic aspects, human health, and social equity need to be addressed along with ocean natural sciences, bridging STEM and the social sciences, fostering a holistic understanding of ocean-related challenges and seek more effectively for solutions (Kennedy 2026).

However, raw data themselves, without analyses and interpretation, carry no precise information, still they are crucial for creating knowledge (Serban and Luan, 2002; Zins, 2007), which results from understanding of information, and thus it is related to acquiring and remembering a bulk of facts and ability to analyze information and hence solve problems.

This paper presents an example of how marine research and monitoring system contribute to advancing ocean literacy through knowledge co-creation, education and collaboration with diverse citizen groups. In our Ocean Literacy activities, we applied a research and monitoring system, CSI-POM2 to involve first teachers and then youth in educational activities.

2. Barriers and opportunities in advancing ocean literacy

We see a lot of positive actions and thus progress in terms of ocean awareness among youth, however, barriers are still observed (Zielinski et al., 2021). Science provides information in a very hermetic and technical thus inaccessible to non-experts form, while most education systems still do not recognize ocean science as an important theme for school curricula, hence there is lack of proper resources or training to integrate ocean science into the education (Shellock et al., 2024). Additionally, limited access to technology in many regions, language barriers and cultural differences still set challenges for effective outreach efforts (Fauville, 2017). Formal education is resistant for fast changes and introduction of new approaches, and many formal educators still seldom search for direct research based sources, instead being faithful to the text books and simply passing information embedded in those (Donert, 2018; Kopke et al., 2019; Kotynska-Zielinska et al., 2020). As a result, students often lack a chance to generate knowledge themselves, not to mention data collection, thus miss the process of conversion of data into precise information, without the remaining knowledge parts, i.e. experience, context, application (Donert, 2018; Fauville et al., 2019; Fischer et al., 2019).

Ocean science is fully inter and multidisciplinary, since it integrates natural science disciplines as well as social sciences. The need for integrative approach requires from the society to understand that the ocean is built of interconnected systems, showing a huge variety of environmental challenges. A real boom in advancing of the ocean monitoring technologies opens the doors for the exploration and understanding of the ocean. New and innovative tools not only boost an increase in knowledge but also provide interesting visual and research data-based modules for education. These may include, interactive maps, live ocean observations with UUVs, bringing the ocean close to students regardless in which part of the globe they are.

Open-access ocean data hubs make ocean data and information open and free to public, including educators, students, policymakers, and citizens, thus any stakeholder can be in direct contact with real ocean data and information, which strengthens trust in science and thus supports ocean literacy to enable non-scientists to see patterns themselves, draw their own conclusions and thus, transfer ocean literacy from passive awareness to the process of active analysis. Ocean monitoring tasks involve ongoing and/or repeated observations over a period of time to observe and report changes in ocean conditions, ecosystems and it provides data necessary for understanding trends and system responses.

Joint actions and networks of scientists, teachers and educators help to co-create educational content, which is in line with philosophy of the frameworks of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), which prioritizes equal access to knowledge and capacity building, accelerating global efforts to foster ocean literacy.

3. Methodology

The CSI-POM2 system was designed to monitor and forecast the state of the southern Baltic and its environmental conditions, thereby providing a modern tool for effective environmental management in the Polish maritime economy and as well as for protecting people and the environment. Therefore, the primary purpose of the system is to provide scientific information and support decision making.

As a result of a number of consultations with various stakeholders, we decided to use its features for educational activities. In fall 2024, we invited educators of both formal and non-formal education and run two day-long workshops entitled: *Using CSI-POM2 tools in modern ocean education*. Both workshops gathered a total of 24 participants representing 18 various educational institutions. Then, in spring 2025, we run a webinar for school teachers, which involved over 25 participants from different institutions. During these events, participants, in groups, discussed opportunities and challenges facing education while using innovative tools such as those developed within the CSI-POM2 project.

According to the SWOT analysis, based on the outcomes of those events, ease of use, free access, and interactive data presentations are the major strengths of CSI-POM2 tools (Table 1).

Table 1. Selected strengths and weaknesses of the CSI-POM system in relation to education.

Strengths	Weaknesses
1. Interdisciplinarity and versatility: The wealth of available information enables interdisciplinary project activities, supporting diverse fields of science, practice, and education. 2. Ease of interpretation of results and access to educational materials: Users can easily interpret modeling results while also having access to basic educational information. 3. Vortex parameter – attractive visualization: Generated maps are visually attractive, enhancing their usability and educational value. 4. Compatibility with current educational topics: The project aligns with a modern approach to formal education, promoting community-oriented learning. 5. Intuitive interface and ease of use: Simple and intuitive interface allows for easy interpretation of results, making the model user-friendly, especially for educational purposes.	1. Inability to generate PDFs: The model only allows for saving results in JPEG format. 2. Lack of targeted educational materials: There is a lack of educational packages tailored to the needs of different audiences, such as students and teachers. 3. Lack of tutorials : There are no educational resources explaining the use of individual parameters, interpretation of results, or lesson examples. 4. Limited information in the "info" section: The information available in the "info" section and its interpretation is limited only to the information contained in the button. A guide, tutorial, or sample lesson is needed. 5. Insufficient project promotion: There is lack of information on the portal's innovative nature, e.g., regarding the high-resolution model, which should be the basis for its promotion.

The above strengths and weaknesses clearly show that the system could/would be a useful toolbox for educational activities, mainly those oriented towards the Baltic Sea but also can very well support activities dedicated to increase of general environmental awareness. To address these apparent needs we prepared educational packages, which we have been successfully using in educational activities since the beginning of 2026, with a total of over 180 educators and teachers who are to be introduced to the educational package of the system by end of May 2026.

4. The CSI-POM2 based educational actions

Integrating ocean science into educational activities supports students with scientific literacy and ecological awareness. Typically, research institutions collaborate with educators to develop age-appropriate, educational materials. Therefore, using the CSI-POM2 products we selected the modules, which can serve to support formal and non-formal education, transforming scientific data into accessible knowledge and create clear message.

We created lessons based on real data collection system features and focused on analyzing changes in e.g. sea surface temperature, salinity or tracking blue algae blooms. We adapted an interactive workshop scheme for students of different ages. The workshops title is: *Fishing from an ocean of data to foster the development of a knowledgeable and sustainability friendly society* and its goal is to explore the features of the CSI-POM2 system in supporting community led action on sustainability, climate action, and community resilience through engagement and outreach. Co-designed in collaboration with European partners and community representatives, the workshop explores opportunities and challenges in communication of scientific information to school students. The workshop procedure is a “live” version (© I live by the Sea Ocean Action) and it is also suitable for an online meeting.

A series of short introductions from the panel (including live links and/or recorded video messages from community groups) precede group work on creation of dedicated sustainability related actions with use of the CSI-POM2 data base and interactive features. During the workshop participants, in groups, use their common knowledge to create effective means/actions for transfer of science-based information with reference to information they can obtain from the CSI-POM2 system. The participants work out the following:

1. First, they search through the CSI-POM2 system to choose the theme they would like to work on, e.g. sea surface temperature changes over a selected period of time.
2. Then, participants decide on who they want to address their information and what format (infographic, brief, video, presentation, etc.) will be most effective?
3. Participants make short analyses of the data set and then create the message to their dedicated group of information recipients.

This can be done during the workshop (short version) or a scheme for the project is created and then each group takes home their work and returns to us with a final product. Meanwhile, our team of researchers is available for discussions, if needed. A typical workshop lasts around 3 hours and 30 minutes and the plan is as follows:

1. Participants sit at 3-5 tables of up to 5 per table. (c. 5 min).
2. Participants divide roles, e.g. data researcher, communication expert, etc. (c. 10 min).
3. Participants get the first part of the Baltic general knowledge questionnaire. (c. 10 min).
4. Short introduction, short lectures about ocean, Baltic, knowledge, data collection. (20 min).
5. Work in groups, starting with the theme selection. (60 min).
6. Break. (20 min).
7. Groups present their projects for max. 15 minutes, including general discussion. (c. 60 min).
8. Participants get the final question (*How does ocean influence you?*). (10 min).
9. Summary by organizers. (10 min).

Acknowledging that each group varies, we have flexibility to modify the structure of the workshop, however, using system products as a basis for the development of the project by each group.

Another educational block involves a set of educational materials, namely lesson plans for educators and students. Each lesson set consists of 2-3 short presentations tailored to the theme, e.g. general info on the coastal area features (e.g. sea breeze), Baltic Sea and the Gulf of Gdansk, and a short video about the CSI-POM2 system from an educational perspective. Then, we provide lesson plan(s) for educators, including full description of the activities, materials and the same package is provided for students (tailored for their needs). A typical lesson plan is as follows (e.g. Sea breeze):

1. Lesson theme: *What is sea breeze?*
2. General lesson objectives: Student knows that breezes occur in the coastal area of the sea, in what direction they blow depending on the time of day, and why the direction changes with the time of day/year.
3. Work methods: Short talk, Presentation, Experiment.
4. Teaching tools: Worksheets plus articles needed for the experiment: 2 metal bowls, Sand, Ice, Candle and a lighter.
5. Lesson plan:
Introduction: Educator explains the characteristics of the coastal zone. Students try to explain the differences between the daytime (heating) and nighttime (heat release).
6. Proper lesson:
Characteristics of winds (speed, direction, strength). The sun as a heat source. Define the concept of a sea breeze and illustrate the phenomenon with images.
Experiment – The experiment requires two metal pots/bowls, ice, sand, and a candle. The experiment should be conducted with the windows closed and be draft-free.
Use a lit candle to check for drafts. Then, pour sand into one container and heat it in an oven/warmer at approximately 300°C (572°F) for up to 8 minutes. Fill the second container with ice and place both containers side by side. Place the lit candle between the containers and then extinguish it. Observe the direction in which the smoke travels.
7. Summary – students respond to questions:
 1. Does the sea breeze occur in every coastal area?
 2. Is the sea breeze only a local phenomenon?
 3. Does the sea breeze occur only on a daily basis, or also on a monthly scale?
8. Formulation of project work/homework: Describe the potential consequences of breeze circulation for coastal areas. Consider the problem of pollutant transfer. Consider the issue of breeze circulation on a monthly scale (monsoons).

5. Conclusions

Fostering and strengthening ocean literacy is a joint challenge, which aims at bridging science, monitoring, education, policy, and community engagement (Shellock et al., 2024). Marine research and monitoring systems provide data, information, hence knowledge that deepens understanding of ocean ecosystems, and facilitates observations of ecosystem changes as well as can relate scientific insights in understandable realities. Both of these “legs” support or should support education, evidence-based policy, and promote and strengthen community engagement in ocean stewardship.

Applying ocean literacy principles fosters much closer connection between abstract concept of the ocean into a tangible, common responsibility, supporting individual, daily actions with global and far reaching consequences (Fauville, 2017). Therefore, societies must depend on science based knowledge to cultivate understanding, facilitate dialogue, and support all citizens in their choices and further acts.

It is researchers co-responsibility to translate their research results to understandable information for societies and to co-create knowledge together with citizens, who e.g. can be involved in the process of creation ocean study models (Fauville, 2017). Our application of the CSI-POM2 Baltic monitoring system for creating educational materials and workshop ideas fits in very well into the idea of fostering Ocean Literacy principles among both local and global society.

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