RESPONSEABLE

Deliverable 5.10

A practical guide for the development of Ocean Literacy material and products

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1. Introduction

This deliverable is a final deliverable of the Work Package 5, it builds on the process of co-developing, testing and evaluating effectiveness of the Ocean Literacy Tools, which were done under this project and were presented in the previous WP5 deliverables and brings out recommendations for each of them and serves as a practical guide on "elaborating and implementing sound processes for supporting the elaboration of Ocean Literacy material and products".

To do this we will report on the findings for each of the tools developed during the project, and the assessment of their effectiveness in order to assist us in evaluating the process that has been developed, identifying its strengths and weaknesses and to help us in proposing any necessary adaptations to the process.

Therefore this deliverable should be a support to further applications in the field of Ocean Literacy in Europe and elsewhere.

This deliverable is organised in the following manner:

Section 2: The Process

In this section we present the process adopted by the project to design, develop, test and assess the Ocean Literacy tools we developed.

Section 3: Evaluation of Effectiveness

In this section we describe the theory and practice, based on the existing state of the art, which we use to develop test instruments for assessing the effectiveness of the Ocean Literacy tools.

Section 4: Lessons Learned

This section presents the findings and lessons learnt from the individual Ocean Literacy tool experiences, which can be applied to future initiatives. In tandem with the design and evaluation processes presented in the previous sections, this is a resource for future developers of Ocean Literacy tools.

Annexes 1-13 Ocean Literacy Tools

In these sections we present in detail the different Ocean Literacy tools, their objectives, testing and assessment and findings, which are summarised in Section 4.

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2. The Process

As part of Work Package 5 (WP5) of ResponSEAble, “Developing interactive and mutual-learning Ocean Literacy tools”, we developed and applied under real life conditions where possible, a process for evolving communication materials and interactive & mutual learning Ocean Literacy products for different target audiences. Due to the very wide range of OL tool types possible, the process is there to act as a support and guideline, rather than being entirely prescriptive.

A core common element to the process is the co-development & testing process, built on the Living Lab principles, and documented in Section .

2.1 Considerations in developing OL tools

Some of the considerations which we identified in our preparatory work and other work packages are listed below.

- It is important to understand the motivations and behavioural models of OL target audiences. This understanding is needed to inspire people to change the way they think and act in relation to ocean matters.
- Knowing does not always lead to doing – cognitive dissonance is a significant challenge in overcoming this inertia. Therefore before embarking on a lengthy and costly OL initiative, it is important to develop a Theory of Change. By this we mean a comprehensive description of how and why the change desired by the OL initiative will actually come about. Effectively a set of desired outcomes and the causal understanding of how these will be achieved through the activities we will undertake.
- Not all stakeholders / audiences are equally “sea-blind” (levels of literacy will vary), so it is dangerous to apply the same theory of change to disparate groups.
- It is important to learn about why actors act the way they do and how they communicate and take information / knowledge on board. We must learn about which communication channels specific actors listen to and trust most.
- The language of communication varies enormously, and we must strive to understand the language of our target audiences. Equally, we must strive to understand the filters which we / they use both in transmitting and receiving information and knowledge. These filters potentially bias and even block out information which is unwelcome or difficult to accept.

We make choices for emotional reasons at least as much if not more than, reasons based on facts or knowledge. Therefore we must make emotional connections between our audiences and the stories we use as vehicles for our OL tools.

2.2 Challenges

The challenge is to produce scientifically valid but engaging communication and learning products which are re-usable in multiple contexts and platforms. The **focus** of ResponSEAble has been on **innovative**, **interactive**, **mutual learning** and **computer-based** Ocean Literacy products that are expected to *complement effectively more traditional ways of engaging citizens.*

OL tools must be capable of **influencing behaviour**, therefore it is vital that we understand the target audience’s **motivations** and **behavioural models**, in order to inspire changes in attitudes and behaviour. Understanding of the problems in overcoming cognitive dissonance, where our behaviour is in conflict with our values and beliefs will be important.

The process developed in ResponSEAble follows a phased approach (see Figure 2-1). During phase 1 we use Living Lab principles to design, build and test our OL tools and then in Phase 2 test them in real-life deployments.

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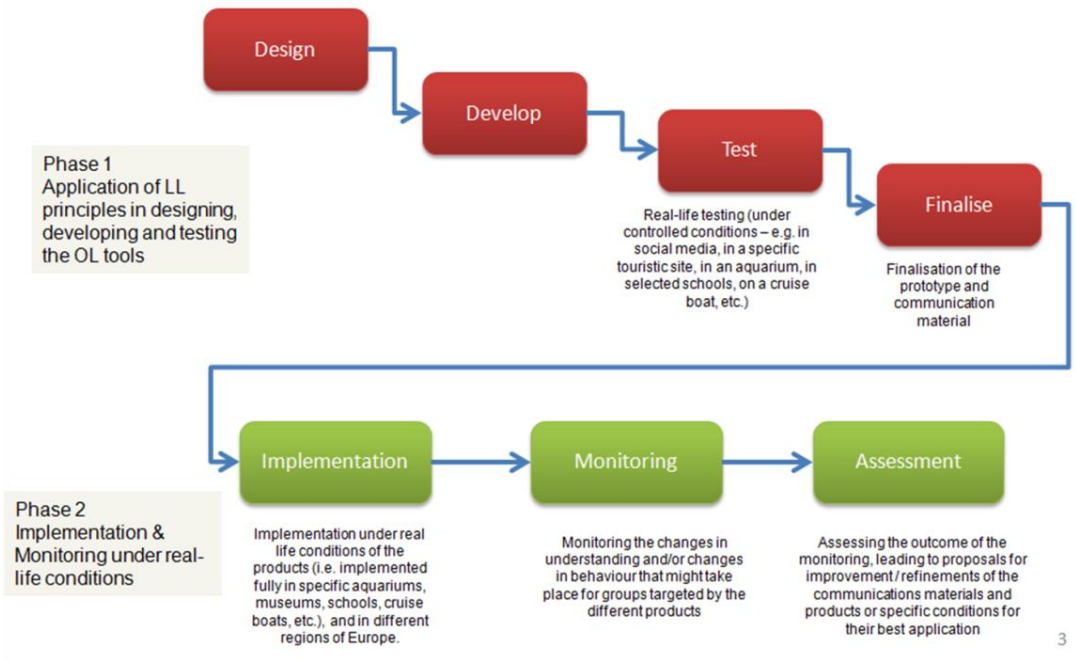

Figure 2-1: Development Process

The process shown here is one possible "*process pattern*". In reality, different types of tools require different engagement with stakeholders and will have different approaches to design, testing and monitoring, depending on the access we have to the ultimate target audience in the different process phases. During the development of the Ocean Literacy tools in WP5, we have learnt quite a lot in terms of how to engage with audiences, assess effectiveness etc., but the overall process, being quite generic, is still valid. The real learning which might be applied in future OL tool developments are those gleaned from our experiences on each tool, and are presented in detail in Sections 5 to 17.

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3. Evaluation of Effectiveness

In this section we describe our approach to the evaluation of OL tools. *Most of the text in this section forms part of a paper submitted as a chapter of a book to be published by the European Association of Geographers and Springer publishers, with the working title "Ocean Literacy: 21st Century Challenges"*

The commonly used definition of Ocean Literacy (OL, 2015), which is to understand "… *the influence the ocean has on you and your influence on the ocean*" is useful, but ultimately we need to be clear about the meaning of the word "*understand*" in this context, and push for not just improved understanding, but the modifications in the *attitudes* and *behaviour* needed for change.

Survey instruments based on the OLP such as the International Ocean Literacy Survey (IOLS) are based on questioning which test an individuals' understanding of the OLP.

Ocean Literacy is aligned with the objectives of environmental education as defined by UNESCO (1975):

- **Awareness**: to help social groups and individuals acquire an awareness of and sensitivity to the global environment and its allied problems.
- **Attitude**: to help social groups and individuals acquire a set of values and feelings of concern for the environment, as well as the motivation to actively participate in environmental improvement and protection.
- **Skills**: to help social groups and individuals acquire the skills for identifying and solving environmental problems.
- **Participation**: to provide social groups and individuals with an opportunity to be actively involved at all levels in working towards resolution of environmental problems.

These objectives align very well with a number of other initiatives in Environmental Literacy, which stress the importance of not just knowledge, but skills and attitudes. For example, the Oregon Environmental Literacy Program[1] describes Environmental Literacy as "An individual's understanding, skills and motivation to make responsible decisions that considers his or her relationships to natural systems, communities and future generations." The P21.org initiative, a coalition of business community, education leaders, and policymakers focused on US K-12 education and skills for the 21st century skills state that an Environmentally Literate[2] student can:

- Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems.
- Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
- Investigate and analyse environmental issues, and make accurate conclusions about effective solutions.
- Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

A common theme across definitions of literacy is that it is not just about knowledge, but our attitudes, our ability to understand complex issues and see alternatives, and how we communicate and act personally and within our communities.

If we focus on behaviour change then the dimensions of Ocean Literacy overlap with recognized 'predictors' of behaviour change studied in social and behavioural sciences (Phal and Wyles, 2017). However, within the broader concept of

[1] http://oelp.oregonstate.edu/oelp-plan/what-environmental-literacy

[2] http://www.battelleforkids.org/networks/p21

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Ocean Literacy these dimensions can be focused on independently for separate Ocean Literacy objectives and audiences. For example, an attitude of concern is not a pre-requisite for problem-solving skills. Likewise, one's attitudes may be formed through moral conviction or social convention, rather than based on in-depth knowledge of the subject. The importance of viewing the OL dimensions in this way (see Figure 3-1) is that we can immediately see the need for and benefit of studying and measuring them separately. It gives us a more fine-grained view of OL, and allows us to tailor campaigns or educational interventions targeted at specific dimensions independently.

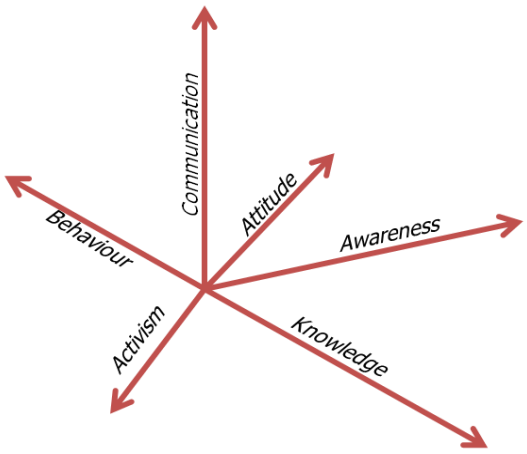

Figure 3-1 : The Ocean Literacy Dimensions

In our framework awareness is defined as the basic knowledge that a situation, problem or concept exists. Knowledge is what a person knows about an ocean related topic and the links between topics. Attitude is related to a level of agreement with or concern for a particular position. Communication is the extent to which a person communicates with others, such as family and peer groups, on ocean related topics. Behaviour relates to decisions, choices, actions, and habits with respect to ocean related issues. Activism is the degree to which a person engages in activities such as campaigning (for example through social media) to bring about changes in policy, attitudes, behaviour, etc.

3.1 Measurement Framework

Assessment of effectiveness focuses on behaviour change objectives of Ocean Literacy initiatives designed for specific actors within each key story. If actors adopt behaviours and lifestyle choices that support sustainable use of the marine and coastal environment, the Ocean Literacy initiatives can be proven to provide tools that aid the concept of 'ocean (or marine) citizenship' (Fletcher and Potts, 2007).

To identify the process required to achieve behaviour change objectives a Theory of Change logic model was adopted (Connell and Kubisch, 1998). The stages, from identification of key stories, actors and behaviour change objectives, through to development of OL initiatives and assessment of tools were also summarised within phases of a step-by-step planning and evaluation model, 'PRECEDE-PROCEED', developed by Green and Kreuter, (1999). The PRECEDE-PROCEED model was originally aimed at directing change/behaviour change processes in health promotion, and has been widely adapted in environmental awareness programmes including the predictors of behaviour change, related to OL dimensions. Applying these models to guide development, assessment and evaluation of Ocean Literacy initiatives in ResponSEAble should enable wider application of the assessment framework to other Ocean Literacy programs. The framework is summarised in Figure 3-2.

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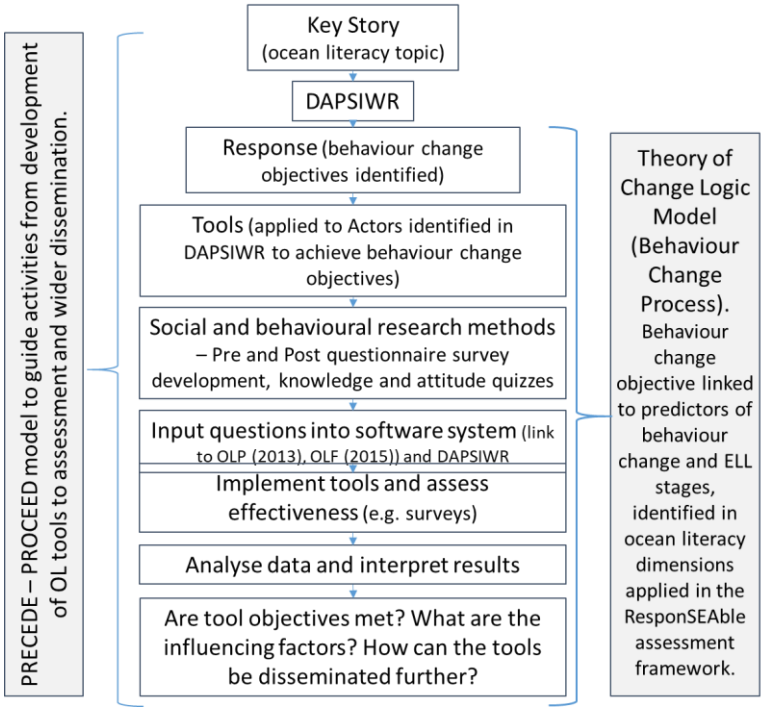

Figure 3-2: Schematic of the assessment framework

To assess effectiveness of Ocean Literacy, the OL dimensions were integrated with predictors of behaviour change identified in social science and psychology literature (Klöckner, 2013; Phal and Wyles, 2017). We applied the 'Theory of Change' logic model (Connel and Kubisch, 1998) to each tool (in relation to the key story / Ocean Literacy topic and the DAPSIWR (Elliott et al., 2017) for that topic) to identify the process the tool used to promote the desired response (behaviour change), and how each of the predictors of behaviour change may be met by the tool. Application of the Theory of Change logic model allowed researchers trained in social and psychology research techniques, tool developers and key story authors to map out a path of how the desired behaviour change, promoted by the tool, would be achieved. Objectives were identified for each predictor of behaviour change and an indicator was set to assess if the objective was achieved (e.g. assessment results, such as questionnaire responses reporting an increase in knowledge about the issue, an increase in belief it was important to act and increased support for adopting behaviour that would reduce the impact on the marine environment).

The full assessment of effectiveness of Ocean Literacy tools applied in ResponSEAble, from review of the DAPSIWR for each Ocean Literacy topic through to implementation tools with participants and assessment of effectiveness, can be summarised within the stages of the PRECEDE – PROCEED model (Gielen and Eileeen, 1996; Green and Kreuter, 1999). The PRECEDE – PROCEED model was originally developed in health research to guide efforts that promoted the uptake of behaviours that supported healthy lifestyles. The model focuses on the principle that a change process should focus on the outcome, not the activity and was applied to initiatives that promoted behaviours to reduce the occurrence of leading causes of disability and death, such as heart disease, stroke, cancer and diabetes (Gielen and Eileeen, 1996; Green and Kreuter, 1999). Summarising the activity taken in the ResponSEAble project within these established models was intended to provide a transferable framework, to aid assessment of effectiveness of Ocean Literacy tools and initiatives at all scales in any regions they may be applied.

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Table 3-1: The relationship between predictors of behaviour change

Predictors of behaviour (Klöckner, 2013)		**Environmental Literacy Ladder (ELL).** (Text in brackets indicates an in-direct connection)	**Ocean Literacy Dimensions Applied in ResponSEAble Assessment (modified ELL)**
Best direct predictors of behaviour	**Intentions** ("I will do this.")	**Collective action:** capacity for personal and collection action and civic participation.	**Behaviour decisions, choices, actions, and habits,** with respect to ocean related issues (either intended behaviour "I will do", self reported behaviour "I do" and level of repetition of behaviour). **Activism**, the degree to which a person engages in protesting and campaigning to bring about political and social change.
	Perceived behaviour control ("It is up to me whether I do this rather than other people or contextual factors").	**Skills:** problem solving and critical thinking skills	
	Habits (behaviours that have become automatized through repetition).	(Collective action)	
Factors having an indirect effect on behaviour	**Attitudes** (favourable or unfavourable evaluations).	**Attitudes:** of appreciation and concern for the environment	**Attitude:** level of agreement with (favourable or unfavourable evaluations) or concern for a particular position, related to impacts and welfare in the DAPSIWR framework i.e. they exist, they are important, and a response is needed.
	Norms (what is seen as commonly done by others).	(Collective action)	**Communication:** extent to which a person engages with ocean related information and how much they communicate about the ocean with family and friends (influence of the social norm)
	Responsibility (ascriptions of who should deal with the problem).	(Attitude)	(Attitude)
	Awareness of consequences (knowledge about impacts).	**Knowledge,** and understanding of human and natural systems and processes	**Knowledge**, what a person knows about an ocean related topic and the links between topics (such as knowledge about impacts of human actions on the ocean environment)
		Awareness: general awareness of the relationship between the environment and human life.	**Awareness:** basic knowledge that a situation, problem or concept exists.
	Values (general trans-situational goals such as equality or individualism).	(Attitude)	(Attitude)
	Negative and positive emotions (such as worry or hope).	(Attitude)	(Attitude)
	Whether people see themselves as environmentalists.	(Attitude)	**Activism:** the degree to which a person engages in protesting and campaigning to bring about political and social change.

Klöckner (2013) concluded that the best direct predictors of behaviour were:

- Intentions ("I will do this").
- Perceived behaviour control ("It is up to me whether I do this rather than other people or contextual factors").
- Habits (behaviours that have become automatised through repetition).

Factors shown to have indirect effects on behaviour were:

- Attitudes (favourable or unfavourable evaluations).
- Norms (what is seen as commonly done by others).
- Responsibility (ascriptions of who should deal with the problem).
- Awareness of consequences (knowledge about impacts).
- Values (general trans-situational goals such as equality or individualism).

Further studies have identified:

- Negative and positive emotions such as worry or hope (Ojala, 2008).
- Whether people see themselves as environmentalists (Whitmarsh and O'Neill, 2010) may also have a role in dictating environmentally conscious behaviour.

These ten social and psychological concepts can be measured and distinguished empirically and provide a rich toolbox for changing behaviour beyond information and knowledge provision (Phal and Wyles, 2014).

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Table 3-2: Relationship of PRECEDE-PROCEED model stages to development and testing and assessment of effectiveness of Ocean Literacy tools

Phase of PRECEDE-PROCEED	**Stage of Development and Assessment of OL tool in ResponSEAble**
PRECEDE	
• Phase 1: Identifying the ultimate desired result.	DAPSIWR: identification of topics to be addressed and the OL tool behaviour change objective (Response).
• Phase 2: Identifying and setting priorities among health or community issues and their behavioural and environmental determinants that stand in the way of achieving that result, or conditions that have to be attained to achieve that result; and identifying the behaviours, lifestyles, and/or environmental factors that affect those issues or conditions.	DAPSIWR: identification of actors and tool participants. Reflection on audience: who the tool will be used by and who will interact with it? Including where tools will be disseminated and existing OL of participants. Development of Theory of Change.
• Phase 3: Identifying the predisposing, enabling, and reinforcing factors that can affect the behaviours, attitudes, and environmental factors given priority in Phase 2.	
• Phase 4: Identifying the administrative and policy factors that influence what can be implemented.	
PROCEED	
• Phase 5: Implementation – the design and actual conducting of the intervention.	OL tool development and testing (living lab). Implementation of tools.
• Phase 6: Process evaluation. Are you actually doing the things you planned to do?	Assessing objectives within Theory of Change, pre and post intervention surveys.
• Phase 7: Impact evaluation. Is the intervention having the desired impact on the target population?	Assessment and analysis of results. Reflection with tool developers, practitioners delivering the tool and researchers who authored the DAPSIWR review: how did the participants respond to the tool? Were the objectives met?
• Phase 8: Outcome evaluation. Is the intervention leading to the outcome (the desired result) that was envisioned in Phase 1?	Reflection on results: what worked well, what could be developed further, how could limitations be addressed, how could suite of tools be disseminated further to develop OL behaviour change objectives in Europe and globally?

3.2 Assessment of effectiveness within stages of the PRECEDE – PROCEED model

The PRECEDE-PROCEED model separates the planning of an initiative, such as an Ocean Literacy tool, and the implementation phase, such as use of the tool with participants (Green and Kreuter, 1999). PRECEDE stands for Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation (Green and Kreuter, 1999). As the acronym implies, it represents the process that precedes, or leads up to, an intervention, and is broken down into four phases (see Table 3-2).

PROCEED spells out Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development, this stage describes how to proceed with the intervention itself. PROCEED also has four phases that cover the actual implementation of the intervention and the careful evaluation of it, working back to the original starting point – the ultimate desired outcome of the process (Green and Kreuter, 1999).

3.3 Analysis of Data

Where possible (i.e. where adequate testing with sample target groups was possible), evaluation data was collected and analysed. The analysis performed by Matthew Ashley of UPM provided deep insight into the effectiveness of the OL tools tested in this way.

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Mean responses of the participants (on a scale of 0-10) in relation to questions associated with each objective in the Theory of Change model were calculated for pre and post survey responses. Such as, level of agreement to the statement *'I believe it will be better for the ocean environment and marine life, if ballast water is treated',* meets the objective that mean group response in post survey ≥7 (Table 5-1). To test significance of changes between pre and post survey responses, paired samples t-tests were calculated and significance defined with Bonferroni correction such that only comparisons with $p < 0.005$ are interpreted as significant. Effect size Cohen's d was reported, calculated by taking the difference between the two means and dividing by the pooled standard deviation (i.e., the root mean square of the two SDs). Here, 0.20 is considered a small effect, 0.50 is medium, 0.80 is large, and >1.20 is very large. The extent to which predictors of behaviour (level of knowledge, agreement with attitude statements and, for study 1 participants level of confidence and self-efficacy, in post surveys) predicted participants intended frequency of undertaking ocean literate behaviour in post surveys were assessed using linear regression calculations to provide r^2 values to assess relationships. Bonferroni corrections and non-parametric measure of effect size were used to provide stricter tests of associations, to account for the small sample sizes and potential bias from students providing responses that may be expected in relation to the course

3.3.1 Measurement of an Effect using Cohen's d

In our analysis of the difference between pre- and post- awareness, knowledge, attitudes, etc., we use a statistical measure of the *effect size*. The effect size can refer to a standardised measure of effect, such as *Cohen's d*[3]. Such standardised measures of effect size are useful when we are using variables such as personality scores, or likes / dislikes, on an arbitrary scale. This very much applies to the type of data on the OL dimensions which we gather using our pre- and post- surveys. The effect size, according to Cohen's d is defined as the difference between the two means, divided by the pooled standard deviation:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s} = \frac{\mu_1 - \mu_2}{s}$$

Where the pooled standard deviation is defined as:

$$s = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

In the above calculation, s_1 and s_2 are the standard deviations of the two (before and after) samples, and n_1 and n_2 are the two sample sizes.

The range of effect sizes is from very small to large (see Figure 3-3), for example according to Cohen (other effect sizes smaller or larger have also been defined).

[3] https://en.wikipedia.org/wiki/Effect_size

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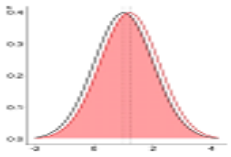
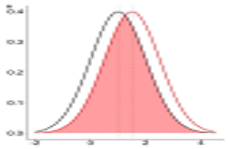
Effect Size	Cohen's d	Visualisation
Small	0.2	
Medium	0.5	
Large	0.8	

Figure 3-3: Effect size ranges

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4. Conclusions and Lessons Learned

In this section we summarise the lessons we have learnt from developing and testing a variety of OL tools. We first summarise our conclusions in terms of:

- Objectives
- Target Audience
- The Design Process
- Design of Test Instruments
- Testing and Analysis of Results

The above sub-sections are then followed by a summary of the findings from our testing of the different OL tools presented. However it is only a summary, and the reader is advised that each of the OL tools is described in more detail in the Annexes, in terms of the approach, development, testing and evaluation, and a more in-depth analysis of the findings and lessons learnt is presented in those sections.

4.1 Objectives

- Accepting change and the need for new (sustainable) practices is challenging. It is difficult to find a balance between financial, environmental and societal demands.
- An Ocean Literacy tool should have specific, realistic, achievable objectives in terms of the OL dimensions. It is extremely useful to develop a Theory of Change model (see Section 3) for Ocean Literacy tools, as we must be clear of the journey from awareness to behaviour change that we would like our intervention to engender in the target audience. This also allows us to specify measurable objectives and measurement instruments.
- Objectives should be active and formulated in terms that indicate what the learner/participant should be able to be aware of, know or do after he or she participates in the course (and not in terms of what the OL tool should do).
- Realistic objectives take into account the target group, their pre-existing levels of Ocean Literacy, and a good analysis of what is achievable.
- Consideration should be given to providing feedback to the users on how they perform (where relevant), so that they are invited to reflect on their experiences.
- We need understand better means of conveying complexity to different audiences. Individuals with improved knowledge of a system are better positioned to make positive behavioural choices, but also more likely to communicate actively (and knowledgeably) on the subject, thereby influencing others.

4.2 Target Audience

- A target group must have the potential to be targeted by something that they have in common. Therefore, the general public is not a good target group for an OL tool. Better would be to use consumers, or better yet consumers of beauty products that contain microplastics. The better your target group is defined, the more effective your tool will be, because the tool can target the group by what they have in common. The age and existing competence level of the target audience must be taken into account.
- The objective of the OL tool should influence the identification of your target group. The OL tool and communication channel that you choose should fit your target group.
- The context in which the tool will be used is a very big factor in its effectiveness. For example, using a video in a teaching setting versus a noise, crowded exhibition.

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4.3 The Design Process

- The Living Lab approach guarantees (if done well) that we take the target group's knowledge and interests into account. It ensures we do not approach the project with an already fixed idea.
- If it is not possible or effective to work with the target group in a living lab setting, it might be possible to work with an intermediary or influencer to act as a proxy / sounding board. Some target groups might be highly resistant to change and might not be effective partners in the living lab process.
- The effort involved in developing content (e.g. game questions) must not be underestimated. Translation adds another level of complexity.
- Look and feel (usability, attractiveness) are highly important, and must be given sufficient attention and resources.
- It is important that a tool has *flow*, that it "tells a story".
- Important design decisions made early in the process will have impacts throughout the rest of the tool life cycle, and must be made carefully.

4.4 Design of Test (of Effectiveness) instruments (e.g. surveys)

- A balance should be achieved between the testing and the course content itself, as testing can interfere with the flow and attention of the participants, and may have an impact on the first day. A pre-questionnaire several weeks before the course or testing session might be preferable.
- Ideally we would incorporate test-instruments into the tool or course. This would make the testing process less intrusive and diminish the impact on the course process.
- It is important but very difficult to develop methods to monitor if intended behaviour has been carried out and what has enabled it; if attitudes remain positive and what the barriers are. Future projects could identify objective indicators of actual behaviour – increase or decrease in use of recycling facilities or increase or decrease in purchase or use of products containing microplastics or sustainable sourced seafood.
- Ideally we should test and improve the test instruments themselves. Analysis of survey results, for example using Rasch analysis, highlights weaknesses in the survey questions, where they have a poor fit with the other questions on the topic, are too easy / difficult, provide better correlation between knowledge and attitude/behaviour etc.

4.5 Testing and Analysis of Results

- Although we can get a general impression of the effectiveness of a tool by looking at the data collected, thorough analysis is required to be done by a specialist, following a specific protocol.
- We make assumptions on the important of knowledge and awareness in changing attitudes and behaviour, but it is important to test our hypotheses with proper statistical analysis. The testing we have done in this project has produced some very interesting results, which are detailed in sections 5-14, but it is clear that further work could be done in assessing the causal relationships between the different dimensions of Ocean Literacy. For example, are our levels of awareness and knowledge the most important factors in our behaviour, or are societal norms and attitudes equally or more important? Our results suggest highly targeted campaigns based on finely tuned theory of change models would have best chance of positive behaviour change results. However this does not mean there is not an important role for tools with broader aims in terms of knowledge and awareness-raising.
- Schools are an ideal place to introduce OL tools. However, it is extremely difficult to get teachers to dedicate the time needed to do proper testing. Pressed for time, teachers preferred for their students to play the game longer and learn content rather than for them to take a few minutes off to fill in assessment forms.

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- Testing at fairs and such events is attractive, but it is difficult to get people's attention for a sufficient amount of time, competing with other stands etc. In our experience, potential participants can shy away when they see evaluation forms being produced.

4.6 Summary of Analysis Findings

In this section we summarise the findings from our evaluation of the effectiveness of the Ocean Literacy tools developed. It is not exhaustive, however, and the reader is advised to consult the relevant sections in the ANNEX to fully understand the testing process and a full description of the findings for each tool.

As we can see from the summaries below, the data indicates that there is strong evidence supporting the use of Ocean Literacy tools and training in achieving improvements across the different Ocean Literacy dimensions.

It remains, however, important that future studies address the lack of data on whether respondents' intentions have been kept, either through self-reported actions or objective indicator data. It is important to develop methods to monitor if intended behaviour has been carried out and what has enabled it, whether attitudes remain positive and what the barriers are. We will need to identify objective indicators of actual behaviour –for example increase or decrease in use of recycling facilities or increase or decrease in purchase or use of products containing microplastics or sustainably sourced seafood.

In terms of the predictors of change, regression analysis showed that the three predictors of change that returned the highest correlation in relation to predicting participants' intentions to undertake behaviours or actions were: pre-existing pro-environmental attitudes, level of communication with others, and attitude towards the benefits of action.

4.6.1 Sustainable Seafaring Course

Participants in the professional training for young seafarers (see Annex 1) in Spain were significantly more informed about invasive species and had greater knowledge of the effects of invasive species on the marine environment and human welfare after the training.

Significant changes were also observed in participant's attitudes. Their concern about the effects of invasive species on native marine life increased, as did their belief that there would be a benefit from treatment of ballast water.

After completing the course, the class, who were in their final months of training before entering the seafaring industry reported a strong intention to frequently undertake actions to reduce or cope with the effects of invasive species on the marine environment). This represented a significant positive change from before reported frequency of actions undertaken prior to the course.

Student's increased their perceptions of the effectiveness for all options to reduce or cope with the spread of invasive species. Following the course there was a significant increase in perceived effectiveness of construction of ballast free ships.

4.6.2 The ResponSEAble Serious Game

The design and development of the game (see Annex 2) proved significantly more challenging than envisaged, in terms of resources, localisation, generation of content and engagement of users in the living lab and testing processes.

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The game was presented at a number of events and sessions in order to gain feedback, but there was limited time for testing of the final full version of the game. However, with the data collected so far, we can make the following assessment.

The game appears to appeal equally to both male and female players. Progress through the game varies considerably, with a large number of players not sticking with the game for more than a couple of days. A small but significant number of players (~30) did stick with the game for more than 1 week, and were rewarded with higher scores as they progressed. However overall, we found a weak correlation between number of correct answers, and total number of days between first and last play. Future consideration would need to be given to incentives, through reward or competition with other players, to keep players engaged.

Our experiences highlight the difficulty in creating a game for the 'general public'. Future developments should probably be more focused on a narrow age group, and reflect their existing interests, knowledge and level of ocean literacy.

4.6.3 "The Ocean and Me" game

The testing undertaken on this highly interactive board and quiz game (see Annex 3) revealed some interesting results. There were strong results for changes in intended behaviours (e.g. "*choose sustainably fished seafood"*) and communication (e.g. "*talk to friends and family about human impacts on the marine environment"*) identified in the Theory of Change model.

There appeared to be a strong correlation between age and gender, and certain attitudes relating to concern for human impact on the marine environment, and belief in the benefits of behaviour change, respectively. Correlations suggested greater age was strongly correlated with greater intention to undertake behaviours requiring purchase of responsibly produced products.

Participant's report a lower current frequency of undertaking the behaviour to '*look for products that do not contain microplastics'* than the behaviour '*choose sustainably sourced seafood*'. This suggests information on microplastics may be new to the participants or they may not have been aware of the means to check and buy products that don't contain microplastics. The significant increase in both options is of interest as this may have an impact if undertaken over time, especially as belief in benefits seemed to be high.

Playing the "*Ocean and Me"* game in the time possible at an exhibition stand provides a snapshot of the issue but the tool appears effective at raising awareness and potentially influencing responses and behaviours. The theory of change Ocean Literacy dimensions were met. There was an increase in intended frequency of undertaking the specific behaviour responses of '*looking for products that do not contain microplastics'* and '*choosing sustainably fished seafood*'. Although the largest proportion of participants were aged 11-15 (64%) and may not be an age group that purchases family shopping it is of interest that average intended frequency to '*look for more information on the impacts of microplastics on the marine environment,'* was high (>7). This suggests the tool raises awareness and supports further development of Ocean Literacy, given the short time participants have for interaction at a busy event such as a science festival or public exhibition on research.

In feedback on what participants enjoyed the most about the game, the overwhelming response was the interactive nature of the game (throwing the ball and talking about the issues) and the quizzes and challenges ("the fun side with the cards, quiz and challenges" - participant at the "Fête de la Science", Brest)

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4.6.4 Kumu's

Presenting the kumu approach (see Annex 4) to (causal) mapping of a topic in an interactive and informative manner, this tool has received very positive feedback from a variety of audiences. We therefore undertook to finish a kumu for each Key Story by the end of the project to add to the legacy of OL tools and resources produced within ResponSEAble.

Our findings to date show that although the tool has great potential for presenting complexity in an interesting way, it requires significant investment of time and design in making the material easy to navigate. Educators in particular have remarked on its potential within the classroom situation to explore topics such as the key stories.

Testing undertaken on the microplastics kumu show moderate to large effects on increasing the knowledge and behaviour OL dimensions. We suspect the lack of impact of attitude and communication may be due to the specific audience tested.

4.6.5 Actors portraits and videos

Although the material received positive feedback (see Annex 5), it was difficult to get the public to engage with them in crowded fairs. The interview-style video format does not appear to compete well with more visual content in such environments, and the portrait videos are better suited to use in a more focused situation such as a classroom, or in self-service booths in quieter venues such as libraries. Likewise the posters are better adapted to such settings.

4.6.6 Zaza workshop – Educational Tool for Children

The Zaza workshops (see Annex 6) were very well received by those schools in which they were piloted. With such a young audience (<8 years old), it is difficult to use the traditional survey-type measurement instruments. Attitudes and intended behaviours can be assessed using simple questions to the group and 'show of hands' type responses. We can also however, gauge the children's reaction, as well as solicit feedback from the teachers. While the teachers involved liked the workshops and felt that it was creative and engaging as well as informative for the children, they are under pressure with their crowded curriculum.

4.6.7 Ocean Literacy Surveys

We undertook a number of surveys (see Annex 7), both to assess effectiveness of interventions as part of the Young Reporters activities in France, as well as to test our ability to assess OL across the various dimensions, and to test question design.

The surveys we undertook, interestingly, did not find a significant correlation between knowledge and either attitude or behaviour. This tallies with other assessments done on the OL tools developed, and is an important finding with respect to the relative importance of trying to increase our target audience's knowledge as a means of changing behaviour. There is a significant correlation however between attitude and behaviour.

Application of analysis tools such as Rasch demonstrated the usefulness of such techniques in improving question design and aligning questions better in terms of their fit with the topic being examined. Distractor analysis highlighted certain questions which could be improved by presenting different options to respondents who are unsure of the answer, or removing options which do not sufficiently distract unsure respondents.

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4.6.8 A series of 6 x 5-minute films

The six short films made on the key story topics were distributed widely online, and subtitled version made available in a number of languages (see Annex 8). After viewing the "Rethinking Plastic" film and participating in the evaluation activities, participants self-reported knowledge about i), how microplastics effect marine life and ii), how microplastics may affect human health, had significantly increased (see Section 12.3). Across the OL dimensions there were medium or greater effects.

After completing the course, the participants who were attending the event from across the UK, reported a strong intention to frequently undertake all actions to: 'help reduce the effects of microplastics on the marine environment in the future'. Self-reported knowledge also increased.

Significant increases occurred in frequency participants reported they would undertake the actions 'looking for products that don't contain microplastics', and, 'supporting shops that don't sell products containing microplastics'.

Showing the films online and requesting the viewers to fill out an online survey also appears to have reaped benefits., providing a number of insights into respondents purchasing and communication habits with respect to plastic, sustainable aquaculture, sustainable tourism, etc.

4.6.9 Interactive Internet Platform

The Interactive Internet Platform was designed to be a self-service interactive, multi-application interface, which can host a number of OL tools, installed in public areas on cruise ships, ferries, aquaria, museums etc.. Testing was carried out on two vessels off the Norwegian coast (see Annex 9). The microplastics in cosmetics key story topic was reported by most participants as being the topic most learnt about on both ships. A small percentage of respondent reported they learnt the most about the 'invasive species in ballast water' topic. A smaller proportion of respondents reported coastal tourism and eutrophication topics as being the ones they learnt the most about. Interestingly the 'top 3' the participants reported they learnt the most about, were also the top 3 topics that were first clicked on in the usage data.

Theory of Change objectives were not met for awareness and knowledge objectives, other than for respondents aboard the Hurtigruten vessel, whereas all Theory of Change objectives were met for indicator questions relating to the Attitude Ocean Literacy dimension. Respondents on board the Hurtigruten vessels displayed high support for undertaking behaviour options, related to the topics they had learnt most about.

Across all samples, respondents identified Government action to be the most effective option to reduce the impact of human activities on the ocean environment, while there was lower (moderate to high) agreement that the most effective option to reduce the impacts of human activities on the ocean environment was individual action.

The analysis showed that it is important to consider that respondents pre-existing emotional dimensions of connection to ocean issues and initial concern for the ocean in evaluating the effectiveness of the Ocean Literacy tool.

4.6.10 Animated Cartoons

The animated cartoons (see Annex 10) were made available online and linked to from a number of different websites and were promoted at public events. The viewing figures were highest for the Invasive Alien Species and Microplastics cartoons. Overall the number of likes was good, with very few dislikes.

Formal pre- and pos- surveys were carried out for the Eutrophication cartoon. An increase in average frequency of respondents in undertaking communication to inform others, and all behaviour options / actions, to reduce the negative effects of excess nutrients entering the sea were reported between pre and post surveys. Although self-reported frequency was not above a moderate frequency (the anchor for between 4 and 6 was 'some of the time'), there was an increase for frequency for every action, and the largest increase occurred for 'informing others about eutrophication',

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'look for information on what meat and dairy products to eat to minimise footprint' and 'buy or eat food with a low environmental footprint.'

4.6.11 A System Dynamics Approach to Increasing Ocean Literacy

The design, OL objectives and resting of the System Dynamics-based tool is presented in Annex 11. Testing was carried out on a mixed group of adults, mainly in 3rd level education. Participants' initial attitude levels were quite high before the intervention, meaning that they were already worried about the damage caused by coastal tourism. They did not often communicate about these issues, however. They had only moderate confidence in their knowledge about how coastal tourism affects the marine and the human environment. They were only moderately likely to take action to reduce the negative effects of coastal tourism (behaviour).

The largest increases were seen for how often participants intend to communicate about the effects of coastal tourism on the marine and human environment, their intention to take action to reduce the negative effects of coastal tourism (behaviour), and their self-reported level of knowledge about the issues.

A 67% increase in mean self-reported knowledge of the damage done to the natural and human environment by coastal tourism was recorded between pre- and post- survey. There was some evidence of a richer understanding of the concept of sustainable coastal tourism (in terms of dynamics and balance).

Awareness was assessed qualitatively: survey responses showed an increase in the number of issues listed by participants post-intervention, a greater emphasis on the need for sustainability and investment in the environment, and an increased awareness of the need to impose regulations on coastal tourism development.

4.6.12 Social Media Campaigns

The first campaign (see Annex 12) focused on Italy, and the Coastal Tourism key story, with the objectives of increasing awareness of the impact of coastal tourism, increasing awareness and knowledge of sustainable tourism practices, and providing good examples of improvements in sustainable tourism. It was found that while there was significant interactions following posts, the comment rate was relatively low, and participation in the online photo challenge was not high. It was felt that investment in paid advertisements would be more effective in targeting the right users, fully taking advantage of the social media platform.

The social media campaign #KeepTheBalticBlue aimed at raising awareness and informing consumers in the Baltic Sea Region that their choice of food makes an impact to the Baltic Sea and that they have a voice as consumers and citizens to make a change. Posts in sevent languages targeted users across the Baltic region. Overall about 179k people were reached, with 6.8k posts and 2.9k likes. Tailoring the campaign and messages to the individuals cultural background was seen to be important. Also, intensive and aggressive posting does not work, when people have an emotional response. For example, linking eating meat and the state of the Baltic Sea elicited a very emotional response and resistance to the message.

4.6.13 Story Map - Eutrophication

The story map (see Annex 13) informs users about the agricultural value chain and how it impacts the ecological status of the Baltic Sea. It reports about stakeholders and actors as well as their roles and responsibilities to act within the food system. The objectives of increasing knowledge and raising awareness of the topic were met. Targeting advanced learners in a university setting who had heard about eutrophication and wanted to know more made this somewhat

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easier. Nevertheless, significant increases in pre- and post- intended behaviour were noted. Also knowledge of effects of eutrophication on human health and wellbeing also showed a large increase between pre and post surveys.

The students group's knowledge about the biological and chemical processes relating to eutrophication, was likely to be high, as it is studied as part of the degree courses they were undertaking. The Eutrophication Story Map was a useful addition to the group's learning, as interaction appears to have raised awareness and knowledge about the extent of the problem, and the impacts on human wellbeing. The student group also suggested increased intention to undertake behaviours to reduce the negative effects of eutrophication in their daily lives.

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ANNEXES

5. Annex 1: Educational Ocean Literacy Tools for Professionals

To keep up with the changes in the fishing industry, including an increased demand for sustainable development, fishers need additional skills, knowledge and information. For many fishers, accepting these changes is difficult, and embracing the need for sustainable development is even more challenging. Consequently, a sound process of including sustainable fishing training in the initial education of fishers would benefit them, the fishing sector and the marine environment in general.

Sustainable fishing training empowers (future) fishers to protect fish stocks and the marine environment for future generations and helps future fishers find a balance between planet (environmental challenges), profit (economic viability), and people (acceptance of your business by society – a license to operate) in shaping their sustainable and successful businesses.

5.1 Overview of the Design and Development Approach

The training course comprises of a wide variety of teaching methods, including interactive lectures, videos, animations, workshops, group assignments, games, quizzes and group presentations. The development of seven OL tools in the ResponSEAble project contributed greatly to the variety of tools, by adding video's, animations, illustrations and slide shows to the course package. Sustainable fishing training covers a wide variety of subjects and this course package offers a basis for the development of sustainable fishing training at fishing academies. It describes a four-day training program:

Day 1: Sustainability (seen as a balance between the three P's: People, Planet and Profit) and marine environment (planet P)

Day 2: Profit P and People P

Day 3: Fisheries management and People P - continued (communication skills)

Day 4: Environmental challenges (planet P) and sustainability planning

The course package aims to inspire and assist fishing academies, their teaching staff and other experts to organize and introduce sustainable fisheries training for future fishers, with the ultimate goal to implement this as a structural element in the school curriculum of all fishing academies.

Therefore, in addition to course content, the package focuses on the challenges of implementation of sustainable fishing training. The fishing sector is unique in many aspects and setting up sustainable fishing training for fishery students in different countries requires that the courses are custom made, and adjusted to education level, language, culture, specifics of the fishing sector and the local environment. Given these special challenges, an important aspect of the implementation process is the building of a national network of partners that work together in customizing the course content for their country, and the execution of pilot courses in different countries to gain hands-on experience.

5.1.1 Seven OL tools -working together with teachers

With the experiences and evaluations of sustainable fishing courses in mind, ProSea wrote a work plan for the development of educational materials. The plan describes a list of 7 new OL tools that can be to be used as part of the

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sustainable fishing courses, but that can also be used as a stand-alone product. The work plan included a short description and an estimate of time and resources needed for the development.

On June 13, 2017, ProSea organized the annual meeting for Dutch fishing academy teachers. In addition to teachers from all five schools, representatives from the fishing sector and from the Dutch Ministry of Economic Affairs were present.

The work plan was discussed and all teachers were positive about the proposed OL tools. They considered them as valuable additions to their educative materials. Especially the animation on the EU Common Fisheries Policy would help the teachers a lot, since many of the teachers and students are not well aware of the CFP and how it works. Some teachers offered to be involved in the development of the OL tools. The entire minutes of the meeting are available in Dutch.

During the development of the OL tools, individual teachers were asked to look at the concept-tools, encouraged to use them in class and to give their opinion on them. In May 2018, finished products were shared with the teachers.

5.1.2 Course package – working together with the OSPAR commission

OSPAR has a stated aim to 'substantially reduce marine litter in the OSPAR Maritime area to levels where the properties and quantities of marine litter do not cause harm to the coastal and marine environment', and the Regional Action Plan for Prevention and Management of Marine Litter in the North-East Atlantic (RAP describes various types of actions that OSPAR is working on. In the RAP, marine litter from fishing is identified as a key area for action, and two actions are specifically aimed at the education of fishers:

- OSPAR Action 58: Develop marine litter assessment sheets to assist Contracting Parties in developing material for education programs, including those for professional seafarers and fishers.
- Contracting Parties National Action 79: Promoting or adopting environmental awareness courses for fishers and the fishing sector.

In the spring of 2017, ProSea was contracted by the Dutch government to conduct a quick survey to get an impression of current education of fishers in OSPAR countries, not only about marine litter, but with the emphasis on 1) sustainability in the school curricula of fishing academies, and 2) the needs and wishes to include this. One of the main conclusions was that Sustainability (People, Planet and Profit) is not structurally implemented as a separate theme in the curricula of fishery education. All interviewed fishing academies (Denmark, Belgium, Ireland and Scotland) were interested in participating in a project to enhance sustainable fishing education.

With these results, and using the work done in the ResponSEAble project, ProSea developed a proposal to implement sustainable fishing training at fishing academies that was presented at the Meeting of the OSPAR Intersessional Correspondence Group on Marine Litter (ICGML) on Corsica in May 2017, and further discussed at the ICGML meeting in Brussel in November 2017. At this November meeting is was decided to explore the possibilities to write a background document for *OSPAR's* Environmental Impacts of Human Activities Committee (*EIHA*) in 2018 and implement an OSPAR Recommendation in 2019.

In addition to working with OSPAR, ProSea is also working with other multipliers including the European fisheries branch organization, the Association of National Organizations of Fishing Enterprises in the European Union (Européche), the European Parliament PECH Committee, the FISH Platform (Fish Industry Safety and Health platform), the International Maritime Organisation IMO, and fishing academies and training institutes in the Netherlands, Belgium, Ireland, UK,

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France, Spain, Germany, Denmark, Latvia, Greece and the Azores to develop plans to implement Sustainable Fishing education.

5.1.3 Theory of Change analysis

The sustainable fishing course covers a wide range of materials and teaching methods. While individual elements of the course may have specific goals or objectives, together they contribute to the overall message of the course and the main messages of the ResponSEAble project:

- We are collectively responsible for the state of the marine ecosystems
- The links between marine ecosystems and people are 'without borders'
- From understanding to ... taking actions (the road might be long)
- A good understanding of DAPSI(W)R, combined with the value chain, is a useful basis for effective Ocean Literacy

The Theory of Change model for the 'sustainable seafaring' education course for young professionals (conducted in Pasaia, Basque Country, Spain) is displayed in Table 5-1.

5.2 Testing Undertaken

5.2.1 Course 1 - Netherlands, fall 2017

In September and October 2017, ProSea conducted 'Fishing with a Future' courses for all Dutch fishing academies. The six courses were attended by 99 students and 13 teachers (some of them participated only part of the program). These courses were paid for by the Dutch government and no ResponSEAble budget was used, but we did use these courses to collect data related to the overall objective of the course and specifically to test one of the new OL tools.

5.2.2 Course 2 - Spain, February 2018

On February 20 and 21, ProSea conducted a marine environmental awareness course for 17 students at a maritime academy in Pasaia (Basque Country) in Spain, in close cooperation with ResponSEAble partner AZTI. This course is developed for seafarers and its main objective was to test its effectiveness in raising Ocean Literacy about the key story Marine Invasive Species.

However, most of the students were future fishers, and since several subjects are similar to the sustainable fishing courses, the course gave us great insight in the effectiveness for fishing students and in the challenges and possibilities to develop a more fishing oriented course in Pasaia. So, we were able to test the course content and the course approach.

Matthew Ashley from Plymouth University was present at the course and he conducted a full effectiveness survey with questionnaires before and after the course, and he documented the results of workshops and student presentations.

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The day after the course, we organized a debriefing with the director and teachers of the maritime academy, scientific institute AZTI, Matthew Ashley from Plymouth and local NGO Mater Museoa. Everyone attending that meeting participated in the course and all were very positive about course content and methodology.

Table 5-1: Theory of Change model for the 'sustainable seafaring' education course for young professionals

Sustainable Shipping Course Theory of Change	**Problem Awareness**	**Knowledge**	**Attitude**	**Attitude - self efficacy**	**Interpersonal Communication / Social Norm**	**Behaviour Change**
Theory of Change: AIM	Following the intervention participants will be aware (informed) of the issue or problem in the key story.	Following the intervention knowledge about the issue (key story) will have increased.	Following the intervention attitude towards the issue would have changed, and change in behaviour supported.	Following the intervention participants feel the response action will be effective and they have the skills and knowledge required.	Following the intervention participants will communicate about the issue or topic with friends, family and at work.	Behaviour adopted or intention expressed:
Measurable objective	i) After the course, mean response of shipping industry professionals (participants) to the question *'how informed about the effects of invasive species on the marine environment?'* (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5)	After the course, i) mean agreement of participants to the statement *'I have good knowledge about how invasive species effect native marine life and how invasive species may affect human welfare.'* will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5). iii) ≥75% of respondents will correctly answer the knowledge quiz question after the course.	After the course, i) mean response of participants to the question *'how concerned are you about the effects of invasive species on native marine life?'* (0-10 scale) will be ≥7. ii) If pre course response is <7 effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5). iii) mean agreement of participants to the statement *'I believe it will be better for the ocean environment and marine life, if ballast water is treated'* (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	After the course, i) mean agreement of participants to the statement, 'I feel capable that when I start to work as a seafarer, I can reduce the spread of invasive species through my everyday actions,' (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's d) will show a medium or greater positive effect (≥0.5).	After the course, i) mean response of participants to the statement, 'How often do you talk about effective means of helping to reduce or cope with the effects of invasive species with family, friends, colleagues or teachers,' (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's d) will show a medium or greater positive effect (≥0.5).	After the course, i) mean response of participants reporting that they *will undertake actions to reduce or cope with the effects of invasive species on the marine environment*, will be ≥7 on 0-10 scale. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).
Indicator	Pre-survey to post- survey responses	Pre-survey to post- survey responses	Pre-survey to post-survey responses	Pre-survey to post- survey responses	Pre-survey to post- survey responses	Pre-survey to post- survey responses

5.2.3 Course 3 - Netherlands and Belgium, autumn 2017

In October and December 2017, ProSea conducted 'Fishing with a Future' courses for one Dutch fishing academy and a fishing academy in Belgium. The courses were attended by 51 students and 3 teachers. These courses were paid for by the Dutch and Belgian government and no ResponSEAble budget was used, but we did use these courses to collect data related to the overall objective of the course and specifically to test one of the new OL tools.

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5.3 Method used to evaluate effectiveness

Here we document the questionnaires or other methods we used in evaluating the tools, and explain the purpose of the questions with respect to the objectives

5.3.1 Spain, February 2018 (c2)

In practical use of the course, a total of 17 students aged 18-44, participated from a technical college in Pasaia, Basque Country. The participants were recruited by course leaders and head teachers at the technical college, and were all in their final months of study before entering the shipping industry.

The pre-course questionnaire included eighteen questions designed to assess participants' awareness of the issue, concern (for damage to the environment) and consideration (of how actions affect the ocean), knowledge, perceived understanding, concern (for effects of invasive species on native marine life), belief and values, confidence and self-efficacy, communication (social norm), responsibility, and self-reported behaviours in relation to reducing or coping with the impacts of invasive non-native species within ballast water. Further questions were designed to assess factors relating to participants' age, location, occupation, pre-existing concern for marine environmental issues and feedback on sources of information on environmental issues. (E.g. *'I feel capable that when I start to work as a seafarer, I can reduce the spread of invasive species through my everyday actions.'*).

Participants were asked to indicate their (dis)agreement with statements, or level of concern, or frequency of stated actions with response options from 0 to 10, with end anchor points labelled "*completely disagree', 'not at all concerned', 'not at all*" and "*completely agree', 'very concerned', 'all the time*". Mid anchor points were included to guide participants following feedback from pilot studies ('*neither agree/disagree', 'moderately concerned', 'some of the time'*). The post-course questionnaire included the same questions. Present tense was changed to future tense in relation to behaviour questions to assess participants' intended behaviour once they work as a seafarer.

5.3.2 The Netherlands and Belgium, 2017 and 2018

In these nine courses, a total of 150 students aged 18-44, participated from five fishing academies in the Netherlands and 1 fishing academy in Belgium. Participation was mandatory as part of their education to become a fisherman. No pre-course questionnaire was used, but data were collected during and after the course.

Data collected during the course included a summary of student opinions on sustainability, the results of some of the course workshops (specifically the TOP 5 workshop), the results of the final group assignment, and presentations and individual questionnaires after the course.

In 2017, in six courses, a post-course questionnaire was used. This questionnaire included questions about participants' opinions about the course and self-reported learning, awareness and behaviour intentions in relation to the sustainable development of the fishing industry.

In 2018, in two courses, knowledge gained during every course day was tested by playing a Kahoot quiz. On the first three days the questions were knowledge based, while the Kahoot quiz after the final day asked questions similar to the post-course-questionnaire used in 2017, which included self-reported learning, awareness and behaviour intentions in relation to the sustainable development of the fishing industry.

Four sets of results are available:

- At the beginning of the course, the students are asked to write down what they think sustainability means. The answers are recorded in all courses. In their workbook and in the final assessment, the students also express their views on sustainability. These answers are recorded in only one course.
- The results of the TOP 5 workshop for two courses: after the opening lecture, the students are working in groups on an assignment to share their views of the TOP 5 issues connected to sustainable fishing. At the end

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of the course the groups get the opportunity to revise their TOP 5, a good indication of what they learned during the course and how their opinions may have changed.

- The results of the use of one of the new OL tools 'who is the best fisherman' for five courses, that involves an inventory of association before use of the tool, the use of the tool, and a set of questions afterwards.
- The results of the post-course questionnaire and the Kahoot quizzes.

As explained above, the method to measure the effectiveness of the course in Spain has been fully based on the Theory of Change, and the data collected during the course in Spain have been fully analysed in relation to with each objective in the Theory of Change model.

During the courses in the Netherlands and Belgium the Theory of Change was still under development (2017) or it was not possible to conduct a pre-survey for other reasons (2018). The data collected have not been fully analysed in relation to each objective in the Theory of Change, but they do provide insight in the general effectiveness of the course, as experienced and shared by the participants as self-reported learning, awareness and behaviour intentions in relation to the sustainable development of the fishing industry.

5.3.3 Analysis performed on the data from the course in Spain

Mean responses of the participants (on a scale of 0-10) in relation to questions associated with each objective in the Theory of Change model were calculated for pre and post survey responses. Such as, level of agreement to the statement *'I believe it will be better for the ocean environment and marine life, if ballast water is treated',* meets the objective that mean group response in post survey ≥7 (Table 5-1). To test significance of changes between pre and post survey responses, paired samples t-tests were calculated and significance defined with Bonferroni correction such that only comparisons with $p < 0.005$ are interpreted as significant. Effect size Cohen's d was reported, calculated by taking the difference between the two means and dividing by the pooled standard deviation (i.e., the root mean square of the two SDs). Here, 0.20 is considered a small effect, 0.50 is medium, 0.80 is large, and >1.20 is very large. The extent to which predictors of behaviour (level of knowledge, agreement with attitude statements and, for study 1 participants level of confidence and self-efficacy, in post surveys) predicted participants intended frequency of undertaking ocean literate behaviour in post surveys were assessed using linear regression calculations to provide r^2 values to assess relationships. Bonferroni corrections and non-parametric measure of effect size were used to provide stricter tests of associations, to account for the small sample sizes and potential bias from students providing responses that may be expected in relation to the course.

Pre and post survey responses were used to assess if objectives within the Theory of Change for the 'Sustainable Seafaring' course had been met (Table 5-2). After completing the course, participants reported they were significantly more informed about invasive species $t(16) = 8.14$, $p < 0.001$, $d=2.5$, and had greater knowledge of the effects of invasive species on the marine environment $t(16) = 6.06$, $p < 0.001$, $d=1.5$, and human welfare $t(16) = -6.23$, $p < 0.001$, $d=1.72$. Significant changes were also observed in participant's attitudes (Figure 5-1). Their concern about the effects of invasive species on native marine life increased $t(16) = 6.94$, $p < 0.001$, $d=1.8$, as did their belief that there would be a benefit from treatment of ballast water $t(16) = 4.56$, $p < 0.001$, $d=1.4$.

Belief that there would be a benefit from treatment of ballast water received almost complete mean agreement (mean agreement = 9 (SE± 0.2)), after the course. Participant's agreement that, after the course, they felt capable that they can reduce the spread of invasive species through everyday actions as seafarers showed a small positive change $t(16) = 1.32$, $p < 0.1$, $d=0.4$. Self-reported frequency of communication with friends, family and colleagues about effective ways of helping to reduce or cope with the effects of invasive species showed a significant increase after the course $t(16) = 2.34$, $p = 0.02$, $d=0.5$. After completing the course, the class, who were in their final months of training before entering the seafaring industry reported a strong intention to frequently undertake actions to reduce or cope with the effects of invasive species on the marine environment (mean response = 7.7 (SE± 0.4) on 0 (not at all) – 10 (all the time) scale).

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This represented a significant positive change from before reported frequency of actions undertaken prior to the course t(16) = 4.37, p <0.001, d=1.4.

Student's increased their perceptions of the effectiveness for all options to reduce or cope with the spread of invasive species. Before the course, perceived effectiveness was moderately high for the options involving, (b), crew to undertake best practice in operation of ballast water treatment, (c), ships to have effective ballast water treatment systems, and (d), research to investigate spread of invasive species and effectiveness of treatment systems. The range for all three options pre course was between 7.0 and 7.2 and increased to between 8.2 and 8.6. Perceived effectiveness was moderate for the option, (a), new ships to be constructed using ballast free designs. Following the course there was a significant increase in perceived effectiveness of construction of ballast free ships t*(16)* = 1.74, p <*0.05, d*=0.8. Effect size (Cohens *d*) showed a large positive effect between pre and post course surveys for all options (*d* = ≥0.8).

Table 5-2 Summary of results of pre- and post- surveys in relation to objectives within the 'Sustainable Seafaring' course theory of change.

	Problem Awareness	**Knowledge**	**Attitude**	**Attitude - self efficacy**	**Interpersonal Communication / Social Norm**	**Behaviour**
Objective	i) After the course, mean response of shipping industry professionals (participants) to the question '*how informed about the effects of invasive species on the marine environment?'* (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5)	After the course, i) mean agreement of participants to the statement *'I have good knowledge about how invasive species effect native marine life and how invasive species may affect human welfare.'* will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5). iii) ≥75% of respondents will correctly answer the knowledge quiz question after the course.	After the course, i) mean response of participants to the question *'how concerned are you about the effects of invasive species on native marine life?'* (0-10 scale) will be ≥7. ii) If pre course response is <7 effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5). iii) mean agreement of participants to the statement *'I believe it will be better for the ocean environment and marine life, if ballast water is treated'* (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	After the course, i) mean agreement of participants to the statement, 'I feel capable that when I start to work as a seafarer, I can reduce the spread of invasive species through my everyday actions,' (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's d) will show a medium or greater positive effect (≥0.5).	After the course, i) mean response of participants to the statement, 'How often do you talk about effective means of helping to reduce or cope with the effects of invasive species with family, friends, colleagues or teachers,' (0-10 scale) will be ≥7. ii) If pre course response is <7, effect size (Cohen's d) will show a medium or greater positive effect (≥0.5).	After the course, i) mean response of participants reporting that they *will undertake actions to reduce or cope with the effects of invasive species on the marine environment*, will be ≥7 on 0-10 scale. ii) If pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).
Result	i), Mean response (post) = 8.4 (SE± 0.3) ii) Mean response (pre) = 4.7 (SE± 1.2) Cohens *d* = 2.5	i), Mean response post (environment) = 7.6 (SE± 0.3) (welfare) = 7.7 (SE± 0.3). ii) Mean response pre (environment) = 4.7 (SE± 0.6) Cohens *d* = 1.5, (welfare) = 4.9 (SE± 0.5) Cohens *d* = 1.7. Correct answer = 88%.	i), Mean response post (concern) = 8.29 (SE± 0.3) (belief) = 9 (SE± 0.2) ii) Mean response pre (concern) = 5.2 (SE± 0.5) Cohens *d* = 1.8, (belief) = 6.8 (SE± 0.5) Cohens *d* = 1.4	i), Mean response (post) = 7.6 (SE± 0.3) ii) Mean response (pre) = 6.8 (SE± 0.5) Cohens *d* = 0.4	i), Mean response (post) = 5.4 (SE± 0.7) ii) Mean response (pre) = 4.0 (SE± 0.7) Cohens *d* = 0.5	i), Mean response (post) = 7.7 (SE± 0.4) ii) Mean response (pre) = 4.7 (SE± 0.7) Cohens *d* = 1.4
Objective achieved? Yes/No	i), **Y** ii), **Y**	i), **Y** ii), **Y**, iii), **Y**	i), **Y**, ii) **Y**, iii)**Y**, iv)**Y**	i), **Y**, ii), N	i), N, ii) N	i), **Y**, ii) **Y**

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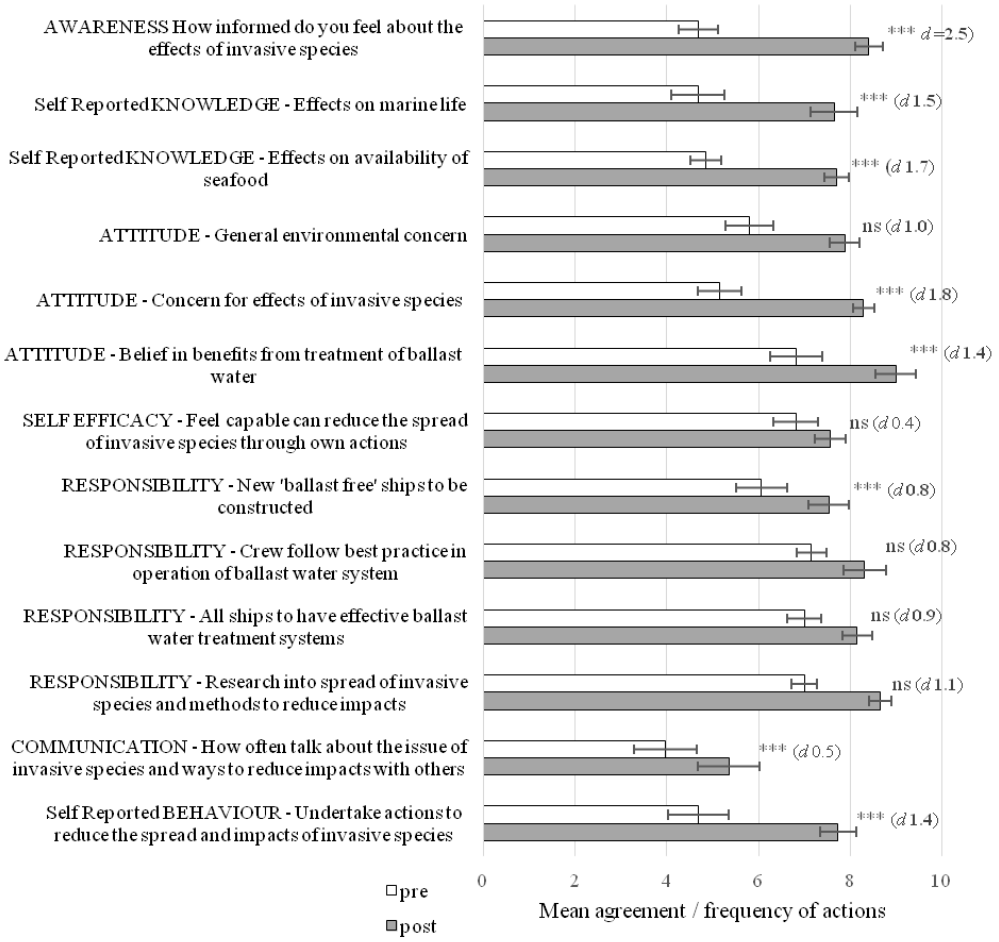

Figure 5-1: Mean participant responses to pre and post surveys completed before and after participating in the 'Sustainable Seafaring' course

5.3.4 Pre-existing environmental connectedness

Before the course, the mean self-reported awareness of environmental issues, and concern about damage to the natural environment was moderately high for the student group (mean 7.2 (SE ±0.5) and mean 7.5 (SE ±0.5) respectively). Agreement with the statement '*I always think about how my actions effect the marine environment*' was moderate before the course (pre) (5.8 SE ±0.6). Proportion of the student group expressing awareness, concern or reflection on the effect of actions on the marine environment, higher than a moderate level (>6), before the course, was 65% (aware), 75% (concern), 35% (reflection on effect of actions). All respondents lived between 0 and 1.8 kilometres from the coast.

5.3.5 Influence of knowledge, awareness and attitude Ocean Literacy dimensions on intended behaviour

For post course responses, the results of linear regression calculations between each predictor of behaviour change and student's level of intention to undertake actions showed weak positive relationships for all predictors of behaviour change. No significant relationship was present, however the 3 predictors of behaviour change that returned the highest r^2 values in relation to predicting level of participants reported level of frequency they intended to undertake behaviours or actions to '*reduce or cope with the effects on invasive species on marine life*' were: pre-existing pro-environmental attitude (r^2 0.13), level of communication with others about impacts (r^2 0.12), and, Attitude (belief in benefits of action) (r^2

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0.1) (Table 5-3). The small sample size may limit effectiveness of this analysis and results should be interpreted with caution.

Table 5-3 Linear regression calculations to assess extent to which predictors of behaviour change (awareness, knowledge, attitude, self-efficacy and social norm) predict participants self-reported intended frequency of undertaking behaviours or actions to reduce the effects of invasive species on native marine life.

Ocean Literacy dimension, correlated with intended behaviour (0-10)	Intended frequency of undertaking behaviours or actions (post intervention)		
	F	**P**	**r²**
'Pre-existing pro-environmental attitude' *'I am concerned about damage to the natural environment'*	1.185	0.29	0.078
'Pre-existing pro-environmental attitude' '*I always think about how my actions affect the environment'*	2.165	0.16	0.126
'How informed' (0-10)	1.224	0.29	0.075
'Knowledge' (environment) (0-10)	1.380	0.26	0.084
'Knowledge' (human welfare) (0-10)	0.097	0.76	0.006
'Attitude' Concern (0-10)	0.131	0.72	0.009
'Attitude' Belief in benefits of action (0-10)	1.544	0.23	0.093
'Self-efficacy' Feel capable can reduce impact through own actions (0-10)	0.374	0.55	0.026
'Responsibility' Crew follow best practice (0-10)	0.011	0.92	0.001
'Communication' with others about impacts (0-10)	0.168	0.17	0.123

5.4 Lessons Learned

The main results of the course in Spain were an increase in Ocean Literacy dimensions – significant for self-reported awareness, knowledge, attitude (concern for effects of invasive species) and intended behaviour (frequency of undertaking). The data from self-reporting from the courses in the Netherlands and Belgium support this conclusion.

Overall, participants report a significant increase in knowledge of sustainable fishing/shipping in general and subjects like invasive species in particular. Most participants report an understanding of the need to be involved and a positive attitude towards the sustainable development of the industry, and an intention to participate in sustainable activities when they are working as fishers or seafarers, including the participation in marine litter collection schemes (Fishing for Litter), the proper performance of ballast water management on board and the development of sustainable fishing techniques.

Comments from students in the final feedback section suggested the participants enjoyed learning about the background information on the marine environment particularly plankton, food webs and marine larvae and productivity of coastal seas.

5.5 Guidance for future development

A full four-day course about sustainable fishing should contain objectives at different levels, including awareness, knowledge, understanding, attitude and behaviour (intentions). Objectives should be active and formulated in terms that

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indicate what the learner/participant should be able to be aware of, know or do after he or she participates in the course (and not in terms of what the OL tool should do).

Be realistic. Base the objectives not only on your desire to change the world, but also on thorough knowledge and respect of your target group, a good analysis of what is achievable with the OL tool under development and a realistic Theory of Change. Objectives should be ambitious enough to challenge course-leaders and target group, but realistic enough that they are achievable with the intended OL tool. Objectives that are too far-reaching may have the opposite effect.

Be specific. Do not formulate the objective in general terms but force yourself to write down what the OL tool should achieve, in terms that are clear and measurable.

5.5.1 Identification of the target audience

Be specific. A target group must have the potential to be targeted by something that they have in common. Therefore, the general public is not a good target group for an OL tool. Better would be to use consumers, or better yet consumers of beauty products that contain microplastics. The better your target group is defined, the more effective your tool will be, because the tool can target the group by what they have in common.

Be consistent. The objective of the OL tool should influence the identification of your target group. The OL tool and communication channel that you choose should fit your target group.

5.5.2 The Design Process / Living Lab approach

It is essential for effective Ocean Literacy education to take knowledge of the target group into account when developing the OL tools.

First, this means that developers should have a thorough interest in and respect for the target group. The living lab is not a trick that can be used to get the target group to take over your views. Working with the target group should be based on a genuine interest in the target group and be based on the objective to empower them to become more Ocean Literate. Developers need to be prepared to listen to the target group and be willing to consider changing their own views and approach when suggested by the target group, obviously keeping the intended objectives of the tool in mind.

Second, it is not always easy or possible to work with the intended target group in a living lab setting. For example, when we target young fishers whose views are that all green organisations are out there to destroy fishing, it is not effective to give them influence in the development of the OL tools that intend to make them more Ocean Literate. Before you can use the target group in a living lab setting, you need willingness from both sides to listen to each other. You have to respect the target group, but the target group also has to respect you. You can still use knowledge of your target group, but it might be hard to involve the target group directly.

Thirdly, when it not possible to work with the target group directly, it is often very effective to work with an intermediate in a living lab setting. For example, in the case of the courses for young fishers, we work with teachers from fishing academies.

5.5.3 Design of Test (of Effectiveness) instruments (e.g. surveys)

While designing test instruments, a balance should be achieved between the testing and the course content itself. In our courses for fishers, the first day is essential in setting the tone and getting the participants not only involved in the subject but also achieve an attitude that they are willing to listen to the information that the course/OL tool is giving to them. Testing, and especially a pre-course questionnaire at the start of the course will have an impact on the first day of the course. A pre-questionnaire several weeks before the course would be better than at the start of the course.

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It would be great if we can design test-instruments that are an integral part of the course (like the Kahoot quiz or the TOP 5 workshop), but also can be used to evaluate the effectiveness. This would make the testing process less intrusive and diminish the impact on the course process.

5.5.4 Testing and Analysis of Results

It is easy to get a general impression about the effectiveness of the courses by looking at the data collected. However, the thorough analysis is work for a specialist. So, to conduct testing, and to analyse/interpret the results so they can be used to improve the effectiveness of the OL tools, this must be done by a specialist, or if one wants to do this as a course developer, one needs to have a very elaborate protocol to follow.

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6. Annex 2:The ResponSEAble App Learning Game

We have a strong need to tell a story in order to involve citizens, tourists and other stakeholders as main actors of a process that requires increase of awareness and behaviour change. For this reason, the serious game seems one of the best ways of engaging people to learn more about the impact of human behaviour on the ocean and also how the ocean affects our everyday life.

Figure 6-1: Game on different devices

6.1 Overview of the Design and Development Approach

The partners involved in the design of the serious game, through a series of meetings, took the following decisions regarding the design:

- The game would be an App Learning Game, more specifically implementing the model of a board game that aimed to make people more ocean literate, providing learning content and testing their knowledge with quizzes and exercises. The content of the game is based on the ResponSEAble Key Stories and it finishes when all the activities for every key story is completed. There is a database of quizzes that are randomly presented, so the game can be played more than once.
- The structure chosen, also following different partners' suggestions, is to start testing the prior knowledge of the player, asking her/him to answer a first question: in this way the player gets feedback that allows her/him to assess his/her previous knowledge; then the game provides some content and after some exploration, the player has to take some decisions in different scenarios. This schema is repeated for every Key Story.
- The game includes some mini games like puzzle, memory, and Simon that are unblocked as the player achieve the completion of each key story.
- The game allows the player to choose an avatar that will be rewarded for every completed stage.
- The target of the game is the general public over 12 years of age, and it uses a graphic layout that reminds one of Disney-like characters, as they are universally liked.
- The player that completes the game is invited to make a selfie that will be published on the leaderboard in order to demonstrate their engagement in protecting the ocean.
- The structure of the game and the questions were implemented following the "pyramid" for behaviour change (information, knowledge, awareness, etc.).

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- The game has the possibility of being translated into any language: for the first iteration we chose English and Italian; then Portuguese would be added.
- The game collects data about the actions of the players: this allows a process of mutual learning. All the data are collected respecting the privacy of the player.
- The game is designed in order to present randomly different questions and situations in order to be played more than once. Moreover the player has a limited number of actions possible for every day. Via the movement points, the idea is to act in a reasoned way, with limited resources. The player receives notifications when the new resources are available.
- The game reused multimedia contents and other resources created by the project.
- The game allows players to share their achievement with their friends on the social media.
- Players that have completed the game, can become part of the ResponSEAblers' "Crew", if he/she accept to take a selfie: it is published on the following address: http://game.responseable.eu.
- The game works on portable devices (smartphone, tablets) and multiple platforms (IOS, ANDROID). It is designed to be extended and modified.
- The game doesn't collect any personal data and it uses the device to set up the language and identify the player. This was done also in order to be compliant with privacy regulations.

The game was developed using a living lab process including experts from different backgrounds such as school teachers, Ocean Literacy experts and game developers.

The game was released several times from February 2018, mostly to implement new content and to test the collection of data for analysis.

The possibility of using beta versions of the game was given to the partners for testing it in different events and contexts. Finally, the game was made available on the online store from November 2018.

In November 2018 a second meeting the Living Lab took place and, in addition to the previous participants, new people were invited: they were educators, experts in circular economy and pedagogy. We presented the game and asked for feedbacks: for some teachers of secondary schools the game was still a bit difficult for the students, but in general they found it engaging and attracting.

6.2 Ocean Literacy Objectives

The ResponSEAble app game aims to provide information, improve knowledge and facilitate reflection on the sustainability of everyday actions; using multimedia, cartoon and quizzes on mobile devices. It is engaging and it is suitable for being used in any context as it requires only a smart phone.

The target is people older than 12 years and no specific skills or knowledge are required. The game is not designed for professionals involved in marine activities. It can be used in an educational context.

The game improves Ocean Literacy through its structure and the different types of activities in the game, and it deals with the following OL dimensions:

- **Knowledge**
  - For each of the 5 key stories, the game provides first a short piece of information and then a quiz to assess the players' knowledge. The idea is to challenge the player and to give him/her feedback; moreover it provides a baseline for a general evaluation of the knowledge of player;
  - The second stage is a learning stage where players have to look at a cartoon and read a text. This stage cannot be bypassed.

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- In the third stage players have to answer three different questions: for example to answer a quiz after looking at an image or a video, or to put some words in the right orders to make a correct statement.

- **Attitude/Behaviour**
  - After the quizzes, a scenario is presented. Essentially it's a story with a plot, characters and a problem that players have to resolve. The protagonist could be a policy maker (the mayor in the coastal tourism story) or a consumer /citizen. The players have two decisions to take with respect to what they have learnt during the game. If the decisions are wrong, the players have to restart the entire key story.
  - After completing a scenario, the players are asked to leave a comment on what they feel they have learned.
- **Activism**
  - When the players complete the game, they are asked to take a selfie that will be published on the leaderboard: their photos demonstrate that they are acting to protect the ocean.

6.3 Testing Undertaken

The game was initially tested by the partners in the internal pilot during the summer 2018 and during the Lisbon partner meeting in September 2018. Partners in the Consortium had the opportunity to test the game also with their students or in public events.

6.3.1 Piedmont Living Lab

As soon as the game was published on the stores, a second living lab meeting was organized by CSP in Torino, in November 2018, to present the game and other OL tools, like films and the Kumu platform. All the people participating in the meeting were experts: they were around 15 and they were teachers, marine researcher and journalists, psychologists.

In collaboration with Matthew Ashley (UPM) a special edition of the survey was prepared and the attendees were invited to complete it. The meeting was very participatory and there was a discussion on how behaviour change can happen: people change their behaviour due to laws/policies or do people support the creation of the policies? The example was the banning of smoking from public place like restaurants, as Italy was the first country to introduce it and many said that this law radically changed people's behaviour. Another group insisted that people should put pressure on the policy makers and in this case schools have a very important role, as often, children put pressure on families to adopt virtuous behaviour, for example in separating rubbish for better recycling.

The teachers were very interested in introducing changes in schools connected with the ocean's issues, for example banning the plastic bottles from serving machine; in addition they said that games are the best way to engage students on topic like this and that they are interested in organizing events in the schools for presenting the game.

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6.3.2 IN-BETWEEN - Do you see the change?

The game was presented during the ***IN-BETWEEN – Do you see the change?*** http://www.in-between.it/ event organized by University of Torino in December 2018, in preparation to the Italian Festival of the Sustainability Development Goals.

The event is organised in collaboration between the Collective Imagine the Future (young collective born in May 2018 by the Albertina Academy of Turin, which intends to promote and sensitize a sustainable future through art and technological innovation), greenTO (association born in 2016 that promotes environmental sustainability within the University of Turin) and CLEVER (Cleantech & Energy innoVation clustER) pole, one 7 Innovation Poles of the Piedmont Region (https://www.poloclever.it/it/) at the Environment Park and financed by the Climate-KIC Alumni Association.

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The event was organized around three themes - Economics, Society and the Environment – with nine talks to explore issues related to the sustainable future and a round table to talk about *Utopia and Sustainable Future* with companies and start-ups, research groups, artists and creatives.

CSP presented ResponSEAble project and the game design process. Some people tested the game, as CSP provided tablets for testing and the public of students and researchers was very interested.

6.4 Evaluation of Effectiveness

During the design phase of the game attention was paid to the possibility of collecting data about the use of the game by the players. For this reason, CSP, 3x1010 (the subcontractor) and NUIG agreed a methodology for exchanging data, through the definition of the data format.

The game sends to a server hosted in CSP all the data related to the games from where they can be downloaded for analysis.

Other data about the players are (anonymously) collected through Google Analytics, regarding the devices used by the players, the time spent and their geographical origin.

In summary, two dimensions were used in evaluating the game:

- **Objective:** 1) collecting data about the actions of the players, through the game itself; every action the player does in the game is registered (but it's anonymous); for example, it's possible to know how many trials the players needs to guess the rights answers, which are the preferred path in the game, etc. 2) collecting data about the number of players, the language, the origin from Google Analytics.
- **Subjective:** 1) through the digital survey linked by the game; through the survey delivered in person during test sessions, events, etc.

6.4.1 Distribution of Players

Figure 6-2 present the distribution of the game players between 21112018 and 16/1/2019. There are slightly more male than female players, and some did not specify gender (n/a = not available).

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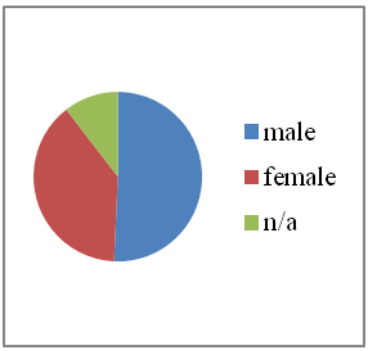

Figure 6-2: Player gender

The breakdown of players by language is presented in Figure 6-3. As you can see, the languages correspond to the languages of the game, but we recorded a small number of players from countries with other languages.

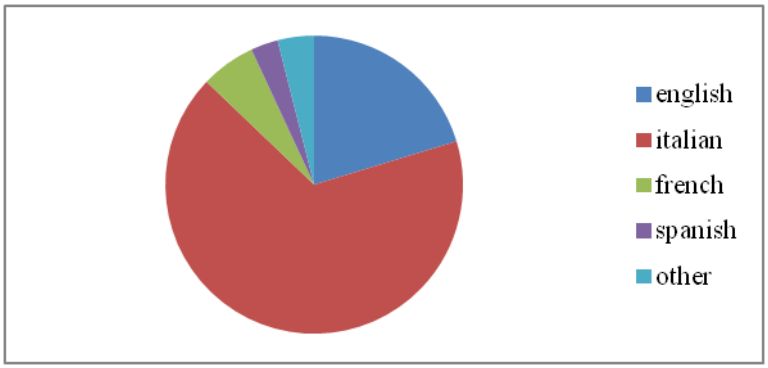

Figure 6-3: Player language

The vast majority of the players were using the Italian language version of the game, with most being female, unlike the English version. In addition we can look at the breakdown of players by language and gender (Figure 6-4).

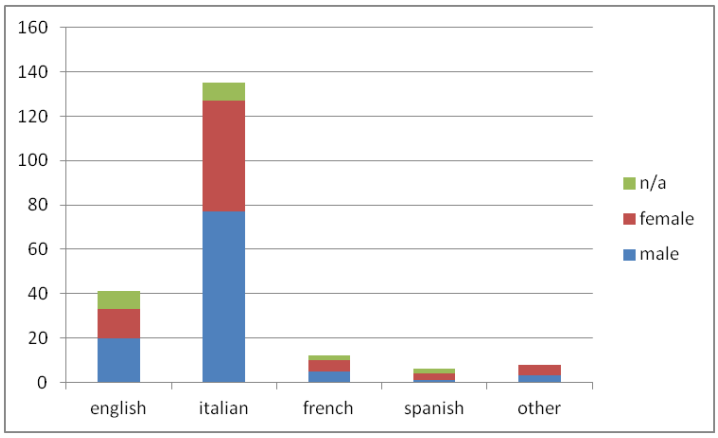

Figure 6-4: Player by language and gender

The number of days between the players first playing the game and their last were unfortunately not as long as hoped. Figure 6-5 shows the number of days the players spent playing the game, with relatively few returning after the first day.

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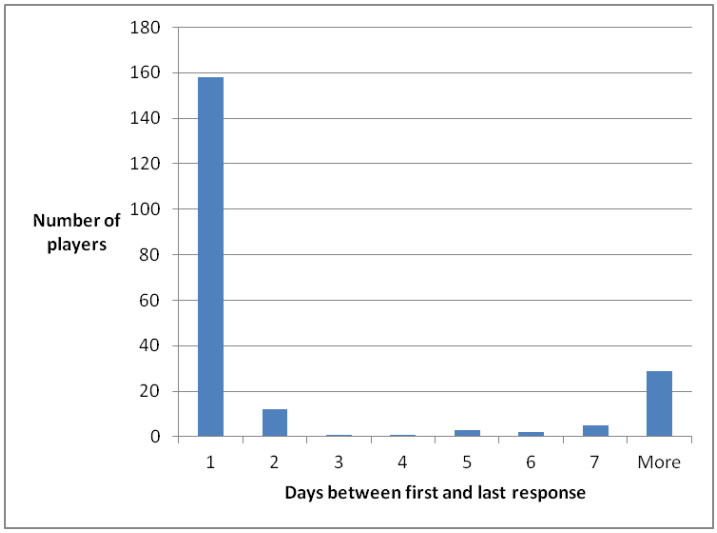

Figure 6-5: Days spent playing the game

When we look at player progression through the game, we see that players gradually get more questions right as they make more responses in the game. While some players had to make multiple posts (responses) to increase their number of correct questions, some progressed much more quickly.

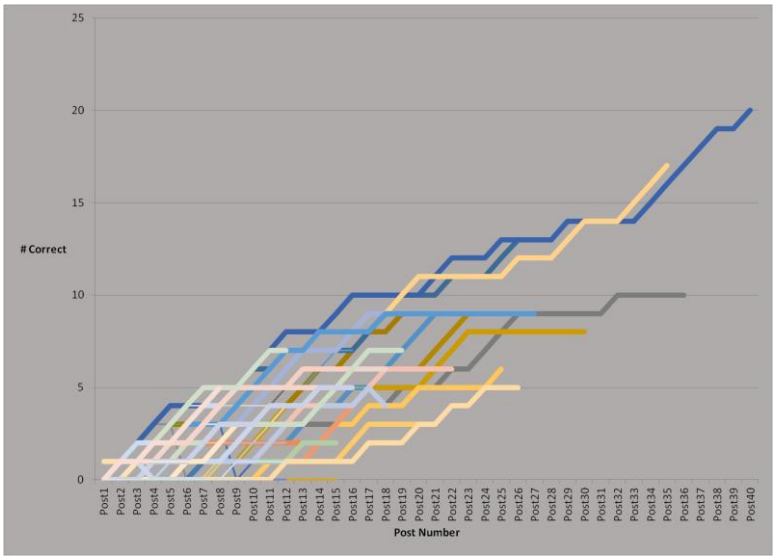

Figure 6-6: Number of Correct Questions by Post Number

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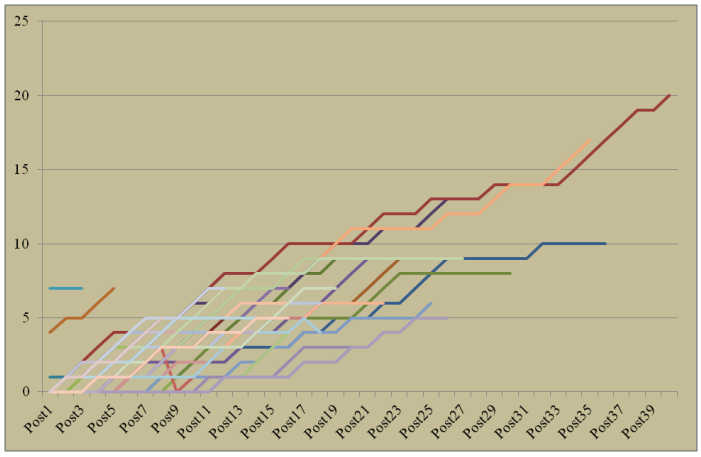

Figure 6-7: Progression of players with most correct answers (>=4)

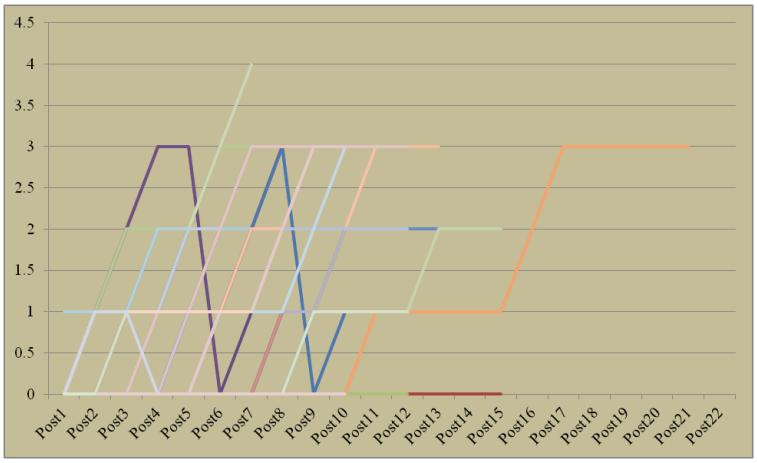

Figure 6-8: Progression of players with least (<4) correct answers

When we analyse the data for correlation (see Figure 6-9) between days spent playing the game and final number of correct answers, we used the Pearson correlation coefficient we found a value off R of 0.4027, which showed a weak correlation.

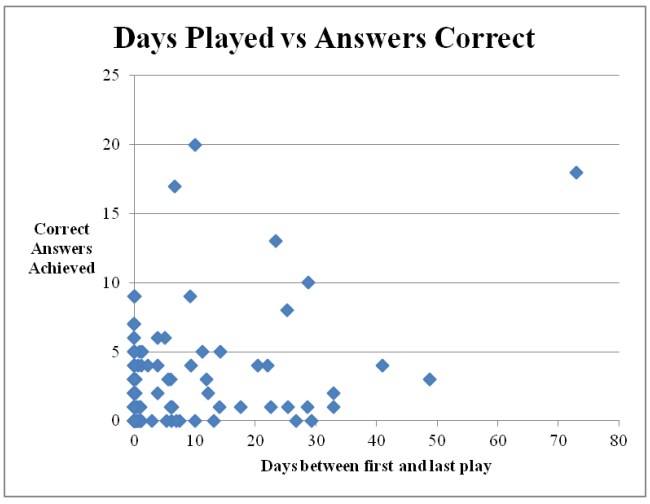

Figure 6-9: Scatter diagram of time from first to last play and overall correct answers

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However, when we removed those players with high scores as outliers (>=10), we found a much weaker correlation, of only 0.177. Finally when we removed those players who spent more than 10 days playing the game, we found an R value of 0.40, again a weak correlation. It is interesting that there is not a significant correlation between the number of days played and the overall score, indicating the perhaps the players were not advancing in their knowledge as they played the game.

6.5 Lessons Learned

Regarding the ***game development***: collecting the questions was more time consuming that expected; it was not an easy task for partners, also considering that it was requested to use DAPSIWR. The questions have to be short, written in an accessible language, fun and engaging.

About the **game**: as we assumed that nobody read the instructions, they were provided directly in the game when the game starts for the first time. Some players complained that the series of balloons were annoying; people don't pay enough attention to the questions also if they can take all the time they want. The look and feel (graphics, music) is very important in attracting people to play the game.

6.5.1 Guidance for future development of OL tools

Most people are not aware of the impact of the ocean on their lives, particularly people living far from the coastline. For this reason, it's important to focus on providing this knowledge. Moreover, it's important to show the impact of day-the-day decisions to demonstrate what everyone can do for protecting ocean life, in order to transform the knowledge and awareness and to sustain the change of behaviour.

6.5.2 Identification of target audience

It is necessary to define the target before starting the design of the game or other OL tools: we decided that the game should be addressed to a non-expert young and adult public, as we assumed that other tools are more effective for other kinds of audience.

In the game we adopted a positive "tone", using a graphic approach that could act on an emotional level, also if the information and the data provided were real. Players are invited to explore and challenge their own knowledge and to be awarded for this. We noticed that people expected that the game was easy and instead they were positively engaged, to find it a bit more difficult.

6.5.3 The Design Process / Living Lab approach

The process of design of the serious/learning game required to take into account many different aspects: the OL objectives, the need of the experts' involvement that brought their scientific knowledge about different topics connected to the sea, the definition of the game mechanic, the decision about the technical aspects, the interaction with many different people and the several constraints, in terms of budget, time, etc.

The interaction with the group of 10-15 experts in the living labs, that included school teachers and journalists, allowed the design team to test and validate the assumptions underlying the game. It was not easy to involve people in the living lab, as we didn't start from their needs or requests and our action was mostly addressed toward the rising of awareness.

6.5.4 Tool Development Process

The subsequent of releases (we made 8 releases before publish it on the stores), allowed us to make corrections and adjustments. The realisation of a complex digital object requires the necessary effort and attention during the design phase, as any assumptions will define the architecture, which cannot be easily modified in the following phases.

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6.5.5 Design of Test (of Effectiveness) instruments (e.g. surveys)

The design of tests requires the definition of the expected outcomes and it is important to provide feedback to the players. In the game, players get a formative assessment in the final scenario of every story, and they are also invited to reflect on what they have learned, as they are invited to write some comments about it.

The surveys are a good instrument to evaluate the level of acceptance of what they experienced through the tools.

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7. Annex 3: 'The Ocean and Me' game

In this section we present an interactive board game which has been developed by UBO and Océanopolis.

7.1 Objectives

The Ocean and Me' game aims to improve awareness, knowledge and behaviour. The game is used to engage a debate with and between the players. It encourages discussion while providing knowledge and possible solutions on ocean sustainability. Whenever possible, the quiz game cards present a solution to an issue, or something the player can do.

7.1.1 Target audience

Developed primarily for public events such as Worlds Ocean Day (8th June 2018), the game targets the general public, from10 years old and up. It can be used in classrooms, at events, during workshops, at aquaria, for children and adults.

7.2 Design and Development Approach

'The Ocean and Me' quiz game is a serious (but fun) board game on ocean sustainability. The quiz cards have a question on one side and a two-level response on the back, so as to give an in-depth response. Played in schools, at training workshops or events, it is adapted for adults and children aged 10 and up.

The game was developed using a living lab process. During 3 workshops, participants (academics, marine educators, students from various backgrounds) brainstormed on either questions they had, or questions they had been asked, about ocean sustainability. This approach made way for a quiz full of original questions with a data base of about 300 questions. The next step was to select a number of questions (approximately 30 for the time being), find a response supported by scientific sources, and write a two-level response (a simple one-sentence response followed by a more in-depth explanatory paragraph), to best adapt the game to a wide audience.

As we were also taking part in the development of the ResponSEAble app serious game by providing questions on sustainable seafood, we thought we would easily be able to use some questions in both games. However, we soon realized this was not as straightforward as expected. Games can choose different question structures. In this process, we discovered three main structure categories:

- The structure chosen by the ResponSEAble serious game app, where the player is first given the core of the knowledge, and then has to respond to a question – of course, the player is then told whether their response is correct or not;
- What we call the "trivial pursuit" structure, where the question leads to a fairly short answer. It can incite the player to discuss the question at hand, or arouse their curiosity but does not provide in depth knowledge;
- A question that is followed by a lengthier response giving the core of the knowledge once the player has answered.

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7.3 Identifying Ocean Literacy Objectives

The "*Ocean and Me"* board game provided knowledge and information about all key story issues within the Respon*SEA*ble project. To complete the game participants had to correctly answer multiple choice questions based on causes and effects of key story issues. Awareness of solutions to reduce or eliminate impacts was also provided by information within the board game. The stages within the theory of change logic model, relating to Ocean Literacy dimensions predicting behaviour change objectives are summarised in Table 7-1.

Table 7-1 : Theory of Change for game

	Problem Awareness /Knowledge	Knowledge	Attitude	Attitude – belief in benefit from own action (self-efficacy)	Interpersonal Communication / Social Norm	Behaviour Change
Theory of Change: AIM	Following the intervention participants will be aware (informed) of the issue or problem in the key story.	Following the intervention knowledge about the issue (key story) will have increased.	Following the intervention attitude towards the issue would have changed, and change in behaviour supported.	Following the intervention participants feel the response action will be effective (there will be a benefit).	Following the intervention participants will communicate about the issue or topic with friends, family and at work or school.	Behaviour adopted or intention expressed:
Measurable objective	Awareness and knowledge about each key story topic are learnt during the game thanks to the questions and response.	Awareness and knowledge about each key story topic are learnt during the game and tested through question and answer cards in the game.	i) After completing the game, average participant's responses to the question: 'Do you think impacts on the marine environment are a problem?' on a scale 0 'not at all' (a problem) to 10 'very much so', will be ≥7 (greater than moderate agreement).	i) After completing the game, average participant's responses to the statement: 'I believe there will be a benefit to the health of the ocean environment and human health if I reduce or eliminate use of products containing microplastics' (0-10 scale) will be ≥7 (greater than moderate agreement).	i) After completing the game, average participant's responses to the statement: 'I talk / will talk about human impacts on the marine environment' on a scale 0 'not at all' (undertake the action) to 10 'all the time', will be ≥7 (greater than moderate frequency). ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.	After the course, mean response of participants will be ≥7 for at 1 of the intended behaviour options to 'help reduce your impact on the marine environment,' ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.
Indicator	Playing the game	Playing the game	Post -game survey responses	Post-game survey responses	Pre-survey to post-survey responses	Pre-survey to post-survey responses

'The Ocean and Me' corresponds to the third question/response structure we identified. We then had to find a way to turn our quiz into an attractive game that would hold its ground during science events. We opted for a poster with a Velcro target for each category of questions and a Velcro ball to aim with, trusting that an original playing format would attract attention. For even more "fun", we also added 12 cards with challenges that players have to do after 3 missed tries of attaining a target with the ball.

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7.4 Testing Undertaken

7.4.1 Survey instrument

A shorter survey tool was used to assess the "Ocean and Me" game, than for events where an Ocean Literacy tool was applied as part of a course or event where participants were engaged with the tool for hours or even days. A smaller range of questions and simplified language was applied to make it more suitable for all ages. The questionnaire was completed after members of the public had played the Ocean and Me game, with assistance of teachers and course leaders. The questionnaire took about 5 minutes or less to complete.

Following piloting the survey tool at Ocean Festival "Fête de l'Océan", Paris, Oceanopolis, UBO, and UOP researchers reviewed the responses to the "*Ocean and Me"* game and the associated survey. The appearance of the survey was re-designed, to provide a more eye-catching and less intimidating (black and white business like) document to encourage responses. Behaviour response options were edited to relate most closely to information in the "*Ocean and Me"* game, that provided actions that could be undertaken by respondents of all ages. Questions were also edited or added to ensure each Ocean Literacy dimension in the Theory of Change were addressed (Table 7-1).

The final survey instrument used in all events after Fête de l'Océan", Paris, included questions designed to assess participant's self-reported responses to questions relating to Ocean Literacy dimensions, predicting behaviour change. Questions addressed attitude (self-reported level of concern) towards effects of general human impacts on the ocean. Respondent's attitude (self-reported level of belief in benefit) in relation to undertaking a behaviour identified in the key story microplastics in cosmetics was also addressed (benefit from reducing or eliminating use of products containing microplastics).

Respondent's current and intended self-reported frequency of '*talking with friends and family about human impacts on the marine environment.*' was approached to address the communication dimension. Participants were asked the frequency they*, 'currently undertake the following actions to reduce your impact on the marine environment'*, and frequency they intend to undertake the same actions, in relation to behaviour responses relating to the key stories Microplastics in Cosmetics and Sustainable Seafood. Only the key stories 'Microplastics in Cosmetics' and 'Sustainable Seafood' had easily identifiable behaviour change response objectives, that could be communicated easily given the limited time the members of the public spent visiting the exhibition stall. As such intended behaviour options focused on these key stories.

Participant's age, gender and distance they live from the sea were also requested. A question asking respondents, '*which environmental problem regarding the ocean are you most concerned about*?, was included to relate responses to other tool assessment surveys to gather data on ocean environmental issues respondents are most concerned about (and aware of) at the time of collecting data.

7.4.2 Methods: Analysis of survey data

Mean responses of the participants (on a scale of 0-10) in relation to questions associated with each objective in the Theory of Change model were calculated for survey responses (pre and post where available) (Table 7-1). To test significance of changes between pre and post survey responses, paired samples t-tests were calculated and significance defined with Bonferroni correction such that only comparisons with $p < 0.005$ are interpreted as significant.

The correlation (Spearman's Rho) between factors: age, gender, location of event and distance respondents lived from the coast and level of responses (0-10) relating to predictors of behaviour change, or intended frequency of undertaking actions to reduce their impact on the marine environment was calculated.

7.4.3 Events

Pilot test: Ocean Festival "Fête de l'Océan", Aquarium Tropical de la Porte Dorée, Paris, June 2018

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The Paris “Aquarium Tropical de la Porte Dorée » took part in World Ocean Day 2018 by organizing a 4 day “Fête de l’Océan” or “Ocean Festival”. This presented us with an opportunity to test the “Ocean and Me” quiz game with both schools and the general public, and pilot test the survey instrument. Indeed, there were over 13500 visitors during the 4 days, including 1500 students.

Despite the number of visitors who came to our stand and played the game, and all our efforts to encourage them to take part in the assessment survey, we can genuinely affirm that this assessment failed: less than 10 surveys were filled out over the four days. Once this fact accepted, it was time for us to try to understand why:

The organization of the event did not simplify the task at hand. The first 2 days were dedicated to schools. We played the game with between 200 and 300 students ages 7 to 16, but the classes were on a very tight schedule, with only 15 minutes per stand. Pressed for time, teachers preferred for their students to play the game longer and learn content rather than for them to take a few minutes off to fill in assessment forms. Over the weekend visitors did have more time.

However, many families had young children, who did not yet know how to write, or who lacked confidence in their writing skills, automatically excluding many players from the assessment.

Also, there were many stands with very fun activities, so we did not manage to convince people to stay for assessment once they had played the game.

One observation we made was that upon seeing the survey, players tended to become skittish and get cold feet. Thus, it seemed important to have something a bit more “eye-friendly”, more engaging. The appearance of the survey was re-designed for future events, using colourful images and font size and layout edited to fit the survey to 2 sides of A5 paper.

7.4.4 Events applying the final survey instrument

European Research Night, November 2018

The game was presented at a stand with a table at two public events, one in Lisbon, Portugal and one in Brest, France, run as part of European Researcher’s Night.

Lisbon

The “*Ocean and Me”* game was set up at a Respon*SEA*ble project stand, during one evening session of European Researcher’s Night at the National Museum of Natural History and Science (coordinated by Museums of the University of Lisbon). Johanna Ballé-Béganton and Matthew Ashley collaborated on the stand to collect as much assessment as possible. The researchers guided interested visitors to the stand through the game and on completing the game invited the participants to provide responses to the survey after explaining the Respon*SEA*ble project assessment, research ethics and informed consent information. The researchers gathered 15 surveys over the course of the evening. The public consisted mainly of young adults, ages 15 to 25. Although there were not very many people visiting the stand, many of those who did visit the stand were actively engaged with the *Ocean and Me* game.

Brest

The “Ocean and Me” game was set up at a stand at European Researcher’s Night at Océanopolis Aquarium, Brest. Seeing as in Brest the European Research Night is hosted by Océanopolis aquarium, and is the only time entry is ever free, we were expecting several thousand visitors in just a few hours. Also, to create a “night” atmosphere, the aquarium’s lighting was dimmed to a minimum. It thus did not seem reasonable to expect any assessment possibilities during the event. With 5284 visitors in less than 4 hours, and almost constantly over 6 people at once on the stand, we indeed were not able to hand out surveys.

Science Festival “Fête de la Science”, Le Quartz, Brest

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The “Fête de la Science”, or “Science Festival”, is an event that takes place once a year in most French cities, the festival promotes science in all its diversity. Schools and, later, the general public can interact with scientists, ask questions about their research and quench their thirst for knowledge. During this year’s edition, more than 5897 visitors were counted, including 2150 students.

Groups of 700 students came to the event for 2-hour periods during which the older students were left to choose which stands they wanted to visit, and the younger children were divided in smaller groups. This gave them more time to spend at a stand if they wished to do so. Over the 4 days we collected 41 filled out surveys.

Mulhouse school

In the end of November 2018, the game was also tested in a primary school workshop setting in Mulhouse (France) organized and conducted by the ACTeon team. Two workshops were held in primary classes with children 9 years old on average. Each class composed of 23 children. Each workshop lasted 1 hour 45 minutes and organized as follows:

- First, an introduction with the presentation of the ResponSEAble project and a brainstorming with 2 general questions: "When I say" ocean / sea "what does it make you think?" and "What do you like in the sea / ocean?". This step lasts about 10 minutes.
- Then the game “Ocean and Me”. The class was divided into two groups to create two teams that each played their turn. We wanted to adapt the game for these workshops because Alsace region is far from the sea and questions could be difficult given the knowledge of children on this subject. So we chose an average of 5 photos for each of the game's questions to illustrate the answer. The game lasts about an hour
- To finish, a drawing time organized in "collective frieze" where each of the children drew on this frieze after having given them as instructions: "Draw us what is most important for you in the sea and the ocean?". This step lasts around 30 minutes.

Two surveys were filled by the two teachers of the classes in Mulhouse. It was not possible to do the surveys with the children for several reasons: (1) lack of time, (2) it was hard to keep the children's attention after a workshop as long and finally (3) the survey was less suitable for children of this young age.

Another workshop is planned for March 2019 with a primary school class (CP) in Strasbourg. The children are on average 6 years old and the workshop will have the same format as the one made in Mulhouse.

7.4.5 Results of Assessment

Demographics and distance participants live from the sea

Data from participants of the Ocean and Me game and survey at Fête de la Science” events in Brest and the European Researcher’s night in Lisbon were combined. The average (mean) age of participants across both locations was 15 SE± 0.6, with greatest proportion of respondents within the age category 11-15 (64%) (Figure 7-1). All participants of the Fête de la Science” events in Brest were aged 10-15, while respondents at the European Researchers night were aged 15-26. Genders of participants completing the survey were almost equal (male 48%, female 52%). A greater proportion of the respondents lived within 5 kilometres of the sea or coast (60%) and a very small proportion of respondents lived over 50 kilometres (approx. 1 hour drive from the coast or sea) (4%) (Figure 7-2). Mean distance from the coast was 16km SE± 6 (two respondents at the Lisbon event were from 200 kilometres from the coast, influencing this result).

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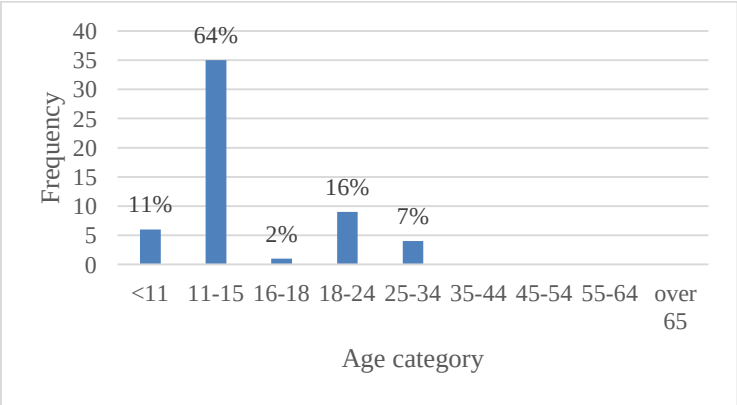

Figure 7-1: Frequency of respondents from each age category

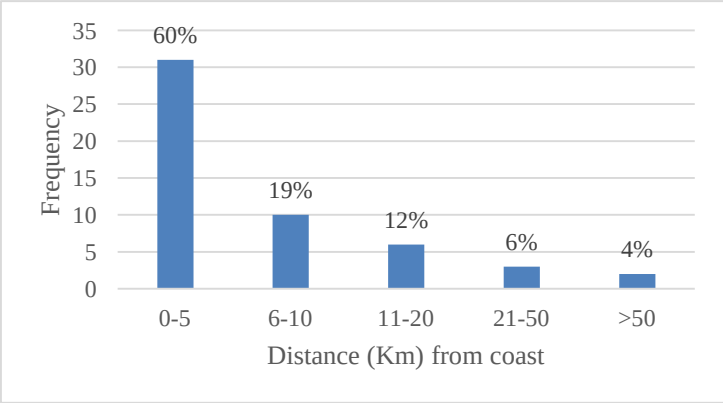

Figure 7-2 Frequency of respondents from each distance category (distance they live) from the coast or sea

7.4.6 Theory of change objectives

All objectives within the theory of Change were met (Table 7-2, Figure 7-3). All intended behaviour objectives were met, although the average response for intended behaviour '*I will look for products that do not contain microplastics,'* was below an intended frequency of 7 (high frequency), there was a significant increase between the self-reported frequency at the time of completing the survey and intended frequency following playing the *Ocean and Me* game. Intended frequency of undertaking behaviours '*Look for more information on effects of microplastics on the marine environment*,' '*choose sustainably fished seafood*,' and the communication indicator '*talk to friends and family about human impacts on the marine environment.'* was high for each behaviour (above 7).

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Table 7-2 Theory of Change model for the Ocean and Me game presented within exhibitions for school aged pupils (ages 10-15, 16-18 and general public 18+)

	Problem Awareness /Knowledge	Knowledge	Attitude	Attitude – belief in benefit from own action (self-efficacy)	Interpersonal Communication / Social Norm	Behaviour Change
Theory of Change: AIM	Following the intervention participants will be aware (informed) of the issue or problem in the key story.	Following the intervention knowledge about the issue (key story) will have increased.	Following the intervention attitude towards the issue would have changed, and change in behaviour supported.	Following the intervention participants feel the response action will be effective (there will be a benefit).	Following the intervention participants will communicate about the issue or topic with friends, family and at work or school.	Behaviour adopted or intention expressed:
Measurable objective	Awareness and knowledge about each key story topic are learnt during the game and tested through question and answer challenges in the game.	Awareness and knowledge about each key story topic are learnt during the game and tested through question and answer challenges in the game.	i) After completing the game, average participant's responses to the question: '*Do you think impacts on the marine environment are a problem?'* on a scale 0 'not at all' (a problem) to 10 'very much so', will be ≥7 (greater than moderate agreement).	i) After completing the game, average participant's responses to the statement: *'I believe there will be a benefit to the health of the ocean environment and human health if I reduce or eliminate use of products containing microplastics'* (0-10 scale) will be ≥7. (greater than moderate agreement).	i) After completing the game, average participant's responses to the statement: *'I talk / will talk about human impacts on the marine environment'* on a scale 0 'not at all' (undertake the action) to 10 'all the time', will be ≥7 (greater than moderate frequency). ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.	After the course, mean response of participants will be ≥7 for at 1 of the intended behaviour options to '*help reduce your impact on the marine environment,'* ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.
Indicator result (objective achieved (Y/N))	Completing the game **(Y)**	Completing the game **(Y)**	Post-game survey responses **(Y)**	Post-game survey responses **(Y)**	Pre-survey to post-survey responses **(Y)**	Pre-survey to post- survey responses **(Y)** *(look for more information on microplastics and buy sustainable seafood)*

Average support for attitudes of concern for human impacts on the marine environment ('*Do you think human impacts on the marine environment are a problem*') and agreement that there, '*will be a benefit to the health of the ocean environment and human health if I reduce or eliminate use of products containing microplastics,*' were very high (>8), after playing the *Ocean and Me* game.

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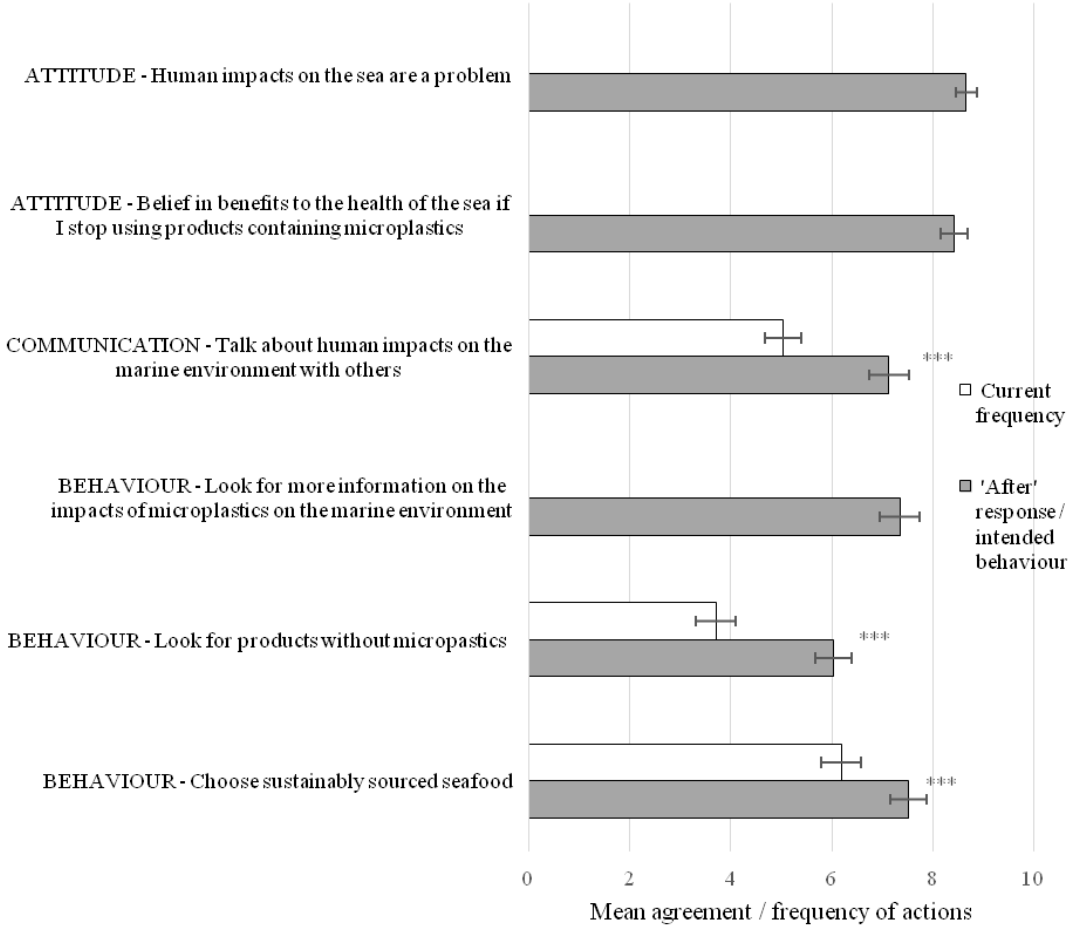

*Figure 7-3 Mean participant responses to surveys completed after participating in the 'Ocean and Me' game, significant differences (p=<0.005) between self-reported current frequency of undertaking behaviours and intended behaviour are indicated by ***.*

7.4.7 Factors influencing level of intended behaviour

Age returned a significant positive correlation with the behaviour '*look for products that do not contain microplastics*.' Location also provided a strong correlation to intended frequency of undertaking this action. Age and location are likely to be linked to the lower age range of Brest event (under 16) compared with Lisbon (15 and over). Greater concern and greater intention to look for products containing microplastics following participation in the game were present in the Lisbon event and the associated older age range of participants (age, Rho 0.5, <*p*=0.005, location, Rho 0.5, <*p*=0.01).

A strong correlation was also present between gender and the agreement with the attitude that there *'would be a benefit to the health of the marine environment and human health if I reduce or eliminate use of products containing micro plastics*.' With females providing greater agreement in a belief in the benefit (Rho 0.283, *p*=0.04) (Table 7-3).

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*Table 7-3 Correlations (Spearman's Rho) between the factors age, gender, distance and event location with level of agreement with statements on questions relating to Ocean Literacy dimensions in the Theory of Change (significant correlations are indicated by *, strong correlations are indicated by bold type.*

	Attitude (concern)		**Attitude (belief in benefit)**		**Communication**		**Behaviour**					
	human impact on marine environment		belief in benefit		talk to friends about human impacts on the sea		choose sustainable seafood		look for products microplastics without		look for information on effects of microplastics	
	Rho	*p*	Rho	*p*	Rho	*p*	Rho	*p*	Rho	*p*	Rho	*p*
Age	**0.505**	**<0.005***	0.067	0.627	-0.154	0.271	0.169	0.232	0.279	**0.039**	-0.186	0.183
Gender	0.208	0.127	0.283	**0.038**	0.13	0.358	-0.019	0.893	0.132	0.274	0.033	0.818
Distance	0.109	0.436	-0.101	0.478	0.2	0.165	-0.064	0.663	-0.123	0.385	0.084	0.562
Event Location	0.299	**0.025**	0.231	0.09	0.007	0.961	0.181	0.199	0.328	**0.014**	0.065	0.642

7.4.8 Discussion – main findings – what they represent

Playing the "*Ocean and Me"* game in the time possible at an exhibition stand provides a snapshot of the issue but the tool appears effective at raising awareness and potentially influencing responses and behaviours. The theory of change Ocean Literacy dimensions were met. There was an increase in intended frequency of undertaking the specific behaviour responses of '*looking for products that do not contain microplastics'* and '*choosing sustainably fished seafood*'. Although the largest proportion of participants were aged 11-15 (64%) and may not be an age group that purchases family shopping it is of interest that average intended frequency to '*look for more information on the impacts of microplastics on the marine environment,'* was high (>7). This suggests the tool raises awareness and supports further development of Ocean Literacy, given the short time participants have for interaction at a busy event such as a science festival or public exhibition on research.

In feedback on what participants enjoyed the most about the game, the overwhelming response was the interactive nature of the game (throwing the ball and talking about the issues) and the quizzes and challenges ("the fun side with the cards, quiz and challenges" - participant at the "Fête de la Science", Brest).

7.4.9 Lessons Learned

Correlations suggested greater age was strongly correlated with greater intention to undertake behaviours requiring purchase of responsibly produced products. Young participants may not have had time to gain detailed knowledge about the causes-effects of issues and the behaviour responses while playing the game, but gained awareness of the issues. It is worth considering that for a younger audience, especially 10-11 years old, who were present at the "Fête de la Science", the exhibitions and events have a lot of interesting stands and there is limited time spent at each one. It is also worth considering too that behaviour responses such as purchasing cosmetic products or seafood are, typically undertaken by older members of a family, or are more relevant to the audience at the Lisbon European Researcher's Night event who were aged 15+.

Diet related behaviour, such as sustainably sourced seafood appears to be moderately supported before playing the game. Participant's report a lower current frequency of undertaking the behaviour to '*look for products that do not contain microplastics'* than the behaviour '*choose sustainably sourced seafood*'. This suggests information on microplastics may be new to the participants or they may not have been aware of the means to check and buy products that don't contain microplastics. The significant increase in both options is of interest as this may have an impact if undertaken over time,

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especially as belief in benefits seemed to be high. It remains, however, important that future studies address the lack of data on respondents intentions have been kept, either through self- reported actions or objective indicator data.

It is important to develop methods to monitor if intended behaviour has been carried out and what has enabled it, if attitudes remain positive and what the barriers are. In future project it is important to identify objective indicators of actual behaviour – increase or decrease in use of recycling facilities or increase or decrease in purchase or use of products containing microplastics or sustainable sourced seafood.

Experience during European Research Night hosted by Océanopolis aquarium

Seeing as in Brest the European Research Night is hosted by Océanopolis aquarium, and is the only time entry is ever free, we were expecting several thousand visitors in just a few hours. Also, to create a “night” atmosphere, the aquarium’s lighting was dimmed to a minimum. It thus did not seem reasonable to expect any assessment possibilities during the event. With 5284 visitors in less than 4 hours, and almost constantly over 6 people at once on the stand, we indeed were not able to hand out surveys.

Océanopolis Fête de l’Océan event in Brest

Despite the number of visitors who came to our stand and played the game, and all our efforts to encourage them to take part in the assessment survey, we can genuinely affirm that this assessment failed: less than 10 surveys were filled out over the four days. Once this fact accepted, it was time for us to try to understand why.

The organization of the event did not simplify the task at hand. The first 2 days were dedicated to schools. We played the game with between 200 and 300 students ages 7 to 16, but the classes were on a very tight schedule, with only 15 minutes per stand. Pressed for time, teachers preferred for their students to play the game longer and learn content rather than for them to take a few minutes off to fill in assessment forms. Over the weekend visitors did have more time. However, many families had young children, who did not yet know how to write, or who lacked confidence in their writing skills, automatically excluding many players from the assessment. Also, there were many stands with very fun activities, so we did not manage to convince people to stay for assessment once they had played the game. One observation we made was that upon seeing the survey, players tended to become skittish and get cold feet. Thus, it seemed important to have something a bit more “eye-friendly”, more engaging.

Mulhouse school

The two teachers appreciated the game and expressed interest in receiving a copy of the game for work on the questions with the students and be able to do it again with next classes. On the frieze of drawings made by the children at the end of the workshop, several children write that they also liked this workshop and they learned about the ocean.

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8. Annex 4: kumu's

One of the problems with Ocean Literacy is that we are attempting to alter people's perceptions and opinions on what are often complex systems. Therefore we are trying to convey a complex causal system to an audience that is largely unaware of such approaches to understanding the world around them and the interactions between human processes and the ecosystem.

In the ResponSEAble project we have used the DAPSIWR framework to model the Key Stories in such a way that attempts to clearly illustrate the causal pathway from Drivers to Impacts (both on the Ecosystem and on Human Welfare) and on to our Responses to them.

Based on an underlying causal map data model, we have used the kumu.io online application to create an interactive online presentation that leads the user through the causal chain from Drivers to Responses.

Effectively this means capturing the DAPSIWR causal chain, as described in the ResponSeable Knowledge Base and Key Story documents, in the underlying kumu graph data model. Once this causal graph has been captured, we have added knowledge to the nodes and relationships in this graph, utilising the work done in WP1-3 in particular. This creates a very rich data set which is then used to create a customised online presentation.

In the following sections we present 2 of the kumu's we have developed, and our findings in assessing them.

8.1 Kumu – Sustainable seafood in Europe

8.1.1 Ocean Literacy Objectives

The 'Sustainable Seafood in Europe' system map (Figure 8-1) targets knowledge, awareness and behaviour. Its goal is to address complexity by helping users understand the issues of the complex socio-ecological system of sustainable seafood in Europe, integrating the numerous feedback loops that exist in fisheries management and seafood consumption.

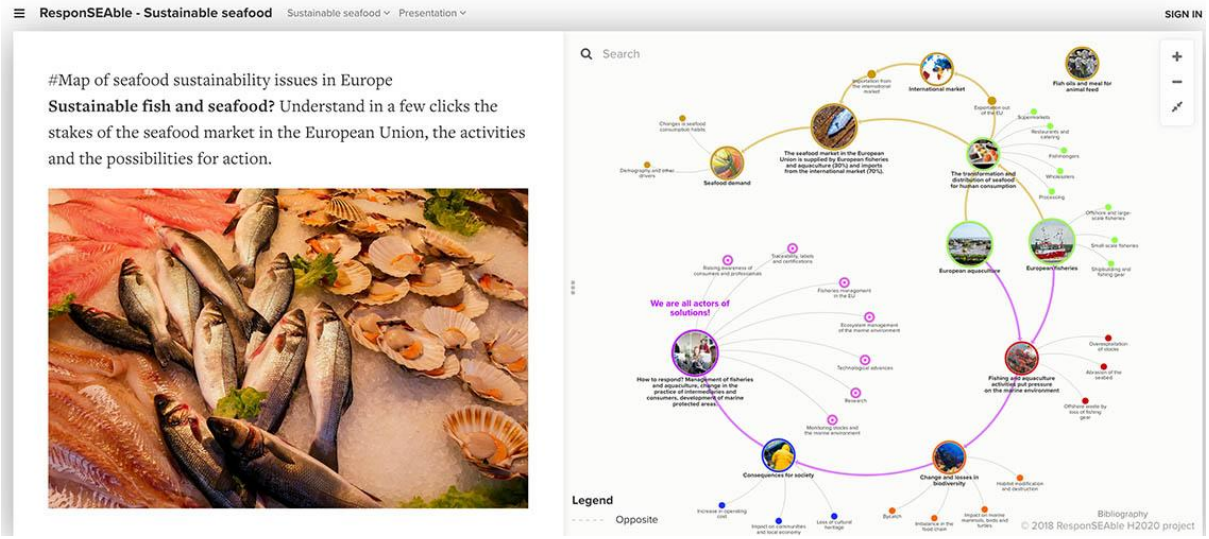

Figure 8-1: Sustainable Seafood in Europe system map

8.1.2 Target audience

The objective of the kumu Sustainable seafood map is to offer integrated knowledge for people who want to transmit knowledge on the subject. For example, a journalist looking for background information for a paper, university professors to support their teaching, or material for professional training workshops. The target is an informed but not necessarily expert public.

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8.1.3 Overview of the Design and Development Approach

To address the complexity of the sustainable seafood issue, we used the DAPSI(W)R (Driver – Activity – Pressure – State – Impact – (Welfare) – Response) analysis framework chosen by the ResponSEAble project. We selected kumu, an online data visualisation platform designed to represent complex information thanks to interactive relationship maps.

The system map is based on the knowledge collected by ResponSEAble WP1-2-3 of the project.

We had to address a number of challenges while designing the kumu map:

- The DAPSIWR framework is a cross between the European DPSIR framework and the ecosystem services framework, with an emphasis on the description of the Activities involved in the socio-ecological system. This cross creates a more detailed representation that is however more complex to communicate.
- kumu is not a hierarchical platform. This made it difficult to find the right level of information. A lot of work was involved in the selection of the content: it had to be simple enough to facilitate the comprehension of the system as a whole and yet have enough depth of information to satisfy an informed audience.
- The data at the European level is not harmonised, a lot of data exists at the global world level or at the national level. Even when it exists at the European level, the definition of Europe often varies in geographical extent. Also, the data comes in very different measurement units making comparison or additions difficult.
- Some information is relayed on the web and is considered to be a verified fact but we often had trouble finding the original source and relevant scientific references.

8.1.4 Testing Undertaken

None as of yet. The target of this tool is for people to build Ocean Literacy material which made it difficult to test the final effectiveness.

8.1.5 Lessons Learned

The Kumu tool was chosen because of the complexity of the issue. At CommOcean 2018, David Shukman of the BBC eloquently expressed why it was easier to communicate about plastics than about other subjects which involve numerous complex interactions that are not as linear. Some issues, such as plastic, are also more visual, making them easier to communicate to large audiences. Sustainable seafood is not as visual as plastic pollution and involves more complex social issues.

The Kumu system map is difficult to navigate. The tool still needs to be improved.

Kumu presents a very interesting tool to communicate complexity, but the tool does not seem totally finalised for this purpose. It is a first approach that yearns to be further developed.

8.1.6 Guidance for future developments

Definition of Ocean Literacy objectives

To be adapted to an informed but not necessarily expert audience, it is important to bring knowledge, but also a relevant viewpoint or framework.

Identification of target audience

Know your target audience.

The Design Process / Living Lab approach

To design the tool, it is important to have a good knowledge of the matter at hand. Do not hesitate to diversify sources and lectures to get the most complete view possible.

Tool Development Process

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The main appeal of the Kumu tool is to showcase a global view of an issue (here, sustainable seafood). It is essential that the map is coherent, that the story flows logically. Feedback and advice from potential tool users can help ensure this.

Design of Test (of Effectiveness) instruments (e.g. surveys)

Testing of this tool depends on the time tables of users. University professors had expressed interest in using the tool in their class, and had agreed to having someone present to test effectiveness of the tool by giving out before and after surveys around knowledge and awareness of the students. However, they preferred to use the tool at a certain time in the school year and could not be available to us whenever we were ready. We thus have not yet been able to test the effectiveness of the Sustainable Seafood Kumu.

8.2 kumu – Microplastics in the Oceans and our Response – A Causal Map

8.2.1 Target Audience

The audience for this tool (Figure 8-2) is the general public. Effectively anyone aged 15 or over should no difficulty in navigating and understanding the tool

Figure 8-2: First page of the presentation

8.2.2 Ocean Literacy Goals

The OL goals of this tool are to increase *Awareness* and *Knowledge* of the user (General Public) of not just the problem of microplastics from cosmetics in the ocean, but to also understand the causal chain of activities and events which leads to the problems and how we are responding. As such it is ideally suited to a group teaching environment, where a teacher or facilitator can lead the group in exploring the map.

By increasing awareness and knowledge we expect to change people's *Attitude* and *Behaviour* with respect to the choices they make, as consumer, producer, etc.

8.2.3 Design and Development Process

The kumu presentation was developed through collaboration with the other partners, and has been packaged as the tool itself, but also the expertise acquired has been shared with the partners so that they can use it to use the tool to create further kumu interactive graphs and presentations to educate and inform.

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The graph is displayed and edited simultaneously in the kumu online tool. We can edit the details for any node (see Figure 8-3) in the graph by clicking on it and editing the content (which is initially imported from the Excel spreadsheet). The editor allows the use of *Markdown* HTML formatting instructions to add images, videos, styling, links, etc.

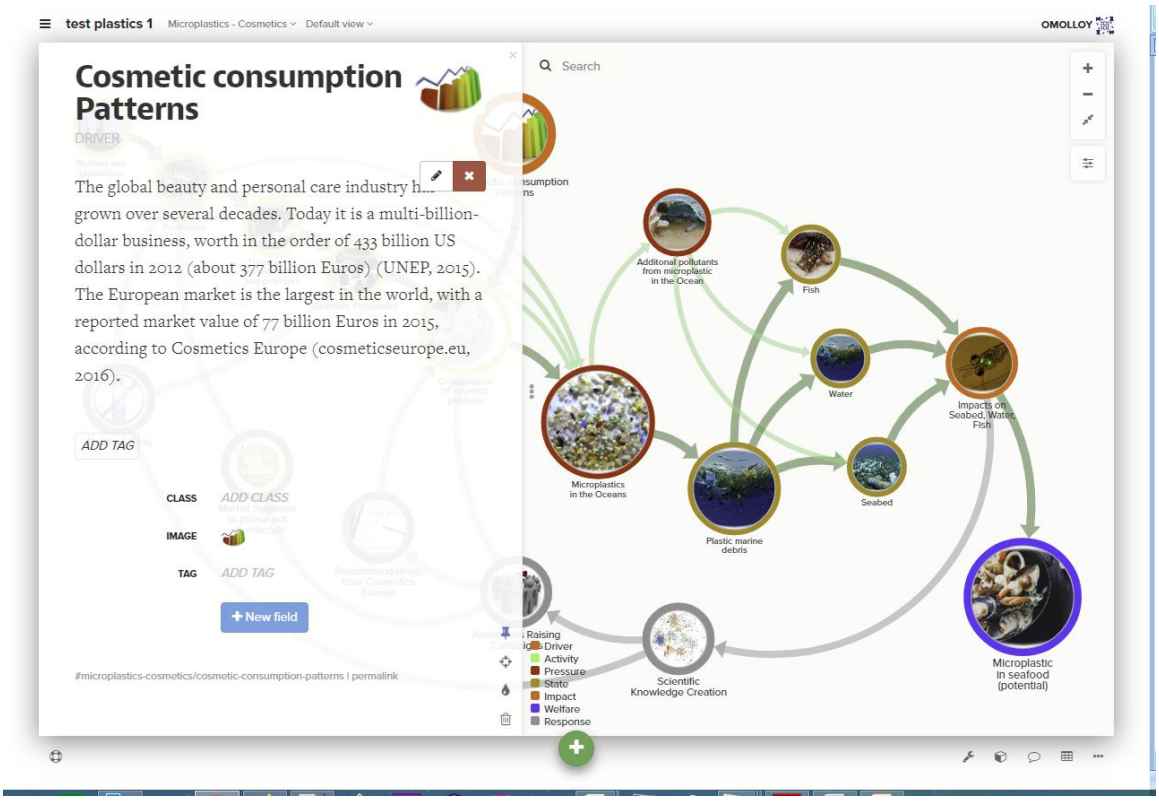

Figure 8-3: kumu editor

As the user navigates the graph they can click on nodes and read / watch the content displayed on the left hand side (see Figure 8-4). This allows us to link to both ResponSeable and other providers content (e.g. on YouTube), providing a very rich information environment for the user to learn the story and the underlying causal map at their own pace.

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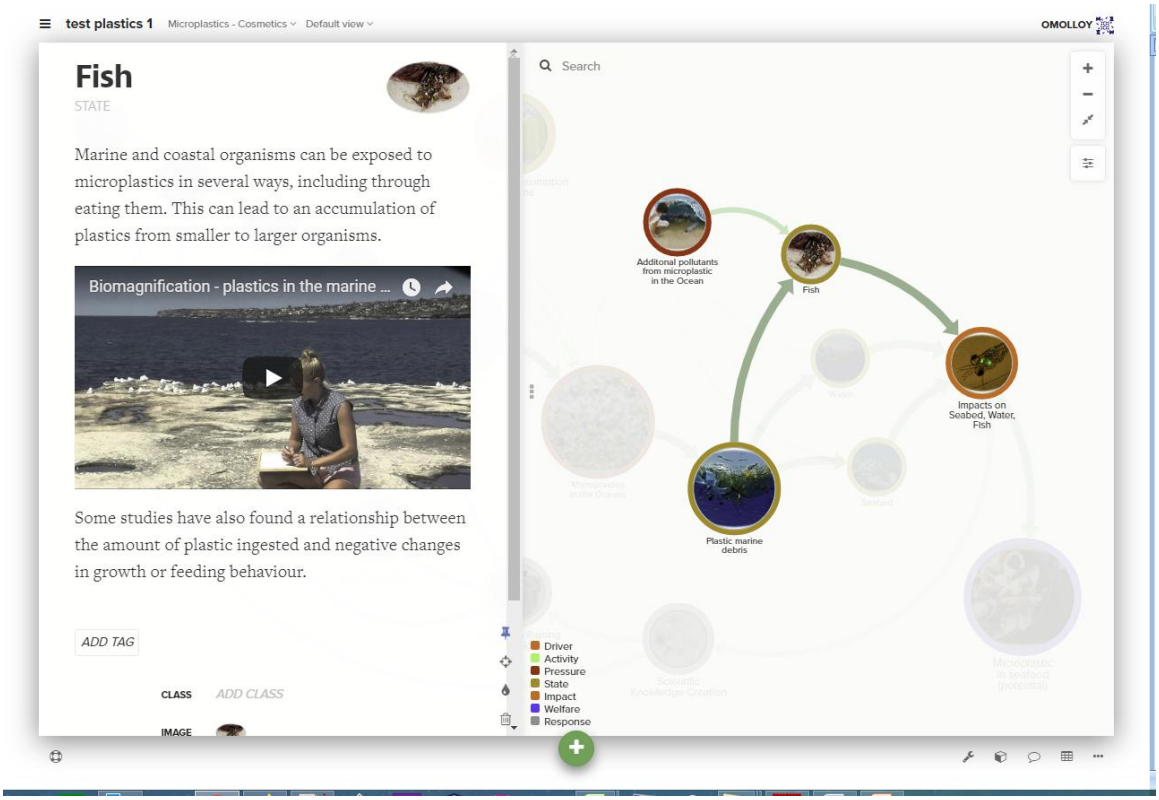

Figure 8-4: Detailed view with links to external resources

8.2.4 Living Lab Approach

As the tool is aimed at a very wide audience, we recruited a range of colleagues and students to try out the tool as it was developed incrementally. The feedback was absorbed and used as the tool was developed to improve the clarity and ease of understanding of the material being presented. One strong feedback is that the tool depends on an understanding of cause-and-effect and of the DAPSIR approach, so that it will be better understood if presented in that broader context. Also, the time needed to fully navigate the kumu is quite long (> 20 minutes), but it would be a very useful teaching tool in a classroom situation.

8.2.5 Monitoring of Effectiveness

The microplastics kumu was tested by Kristīna Veidemane of BEF Latvia with MSc students. Although there were just a small number of students surveyed (10), the feedback was quite positive. Overall, the pre- and post- surveys show an increase in Knowledge and intended Behaviour (see Figure 8-5), whereas, there were, on average, no significant change in Attitude and Communication. This is not particularly surprising, as the students are engaged in environmental studies, and would already be aware of problems, although the exposure to the tool has increased their Knowledge, and also apparently convinced them of the worth of behaviour change. Cohen's d values are as follows:

- Knowledge: 1.5 (large positive effect)
- Attitude: 0.23 (small positive effect)
- Communication: 0.0 (no effect)
- Behaviour: 0.71 (moderate effect)

It was surprising (although the sample was small) that there was such a small effect on communication.

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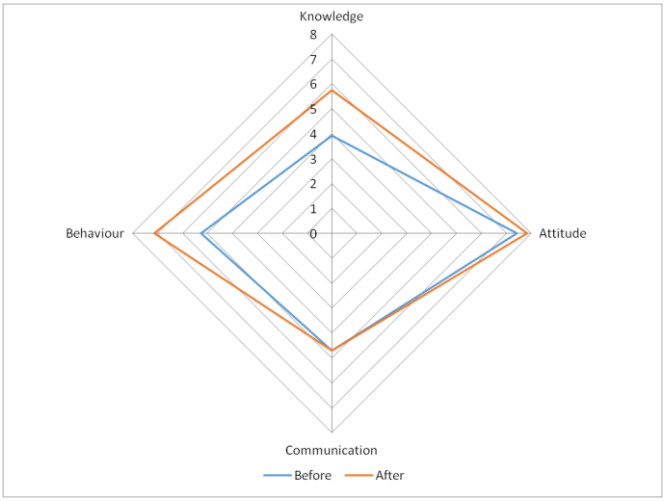

Figure 8-5: Average change in Ocean Literacy dimensions

8.2.6 Qualitative Feedback

There was also an opportunity to solicit feedback on the tool during an informal Q&A session. Some of the feedback is listed below.

What facts/data should/could be added?

- Fishnets (lost; relicts) – they are also made out of plastic and micro-particles end-up in the marine environment.
- Focus on cosmetic seems to me too narrow for understanding the complexity of DAPSIR.
- There would be a need to highlight the importance of a ban not only at national level but also at EU/global.
- A Poster at the beach for awareness raising – this could be as a potential response measure for common people. The example of such a poster would be very helpful.
- Highlight the importance of promotion of substitution of substances, and support mechanisms, e.g. taxes.
- The challenge of the capacity and technology for waste water treatment plants to deal with microplastics could be more highlighted. We could check whether waste water treatment plants monitor microplastics.
- Use numbers to provide evidence e.g., if one person stops using cosmetic, how many kg of plastic can they eliminate per year?
- Provide more information on how people can change their behaviour – links to studies, eco-labels, etc.
- To show more on health impacts from the use of the plastic containing substances.
- Show the link between a river and ocean – many people have a perception that they live too far from ocean to matter.
- Can we collect microplastics from water?

What other data sources would you like to suggest?

- Scientific journals; more official sources from governmental institutions.
- Social media as a tool to highlight the problem.

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9. Annex 5: Actors portraits and videos

The collection of actor's portraits, developed by UBO and Océanopolis, targets knowledge, awareness, attitude and behaviour. It aims at communicating the complex issues of sustainable seafood and microplastics in cosmetics (and marine plastic pollution at large) with a key actor approach. The portraits will highlight both the interviewee's knowledge of the issue and the reasons that encouraged them to change or the obstacles preventing them to change their behaviour.

9.1 Target audience

The portraits being in both a video format for social media and aquaria, and in a poster format for exhibits, we are targeting the general public, namely adults at the local level.

9.2 Overview of the Design and Development Approach

To communicate with a key actor approach, one must first identify the different actors in the value chain. Once this is done, we started contacting the identified actors to ask them if they would accept to be interviewed on the subject. Whenever possible, we tried to interview the person at their workplace so that the photos would be more representative.

Seeing as we wished to give the interviewee a fair amount of freedom in what they tell us while nonetheless remaining focussed on the issue of interest, we opted for a semi-directive interview style. This involved preparing an interview guide with the main topics we wished to address as well as more specific questions if ever the person needed to be encouraged.

The interviews are used as a communication tool and we record all the interviews. In order to do so lawfully, we created an authorization form that each interviewee had to sign before starting the interview.

Every person contacted accepted the interview.

The interviews lasted generally between 45 minutes and an hour. After the interview, we took photographs of the person or of their surroundings. We also asked 3 of the interviewees if they would accept a second, much shorter, filmed interview later on.

After each recorded interview, we had to transcribe it, to ensure we would get citations right and be able to work with the material.

9.2.1 Posters

Using the interview transcriptions, we chose one main angle for each poster (for instance: the moment of behaviour change, or an obstacle they encountered). We also added one "bubble" of scientific knowledge that enriches what the interviewee says, as well as a causal circle of the issue (that remains the same on each poster in that theme).

Once all of the content was selected, we had to work on the graphic design of the postern as well as edit the document (e.g. Figure 9-1).

9.2.2 Videos

Before coming back for the second interview, we created a much shorter interview guide so that the final video would remain under 4 minutes. The videos were done by an Océanopolis professional cameraman and video editor who came to film the interview, and then took charge of the editing. Since ResponSEAble is an international project, we also had to transcribe the video in order to translate and add English subtitles.

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Figure 9-1 : Sample Actor Portrait poster

Here is an example of the interview guide on microplastics:

Objectives

- Understand the relationship between the ocean and the interviewee
- Highlight the links between the ocean and the profession of the person
- Learn what each interviewee does to reduce their impact on the sea
- Propose a written format
- Highlight the triggers for behavioural changes in the use of products containing microplastics

The ocean and you

- Who are you?
- How will you describe your job / profession?
- How far from the ocean do you live?
- How often do you go to the seaside?
- What do you think are the major issues for the health of the ocean?

The challenge of microplastics - Your job and the ocean

- What are microplastics for you?
- What are the issues that arise from the use of microplastics in cosmetics for the ocean?
- What should be done? Where do you think we need to act?

Action

- Did you act?

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- Where / how did you act?
- What was the trigger? What made you want to change your behaviour? What made you aware of the importance of microplastics? Where did you get the information?
- What are the difficulties?
- Effective OL: What could be done to make people aware of microplastics effectively?

Consumer / Intermediate Questions

- What are your main criteria when choosing / buying a cosmetic product (e.g. deodorant, toothpaste, shampoo, soap) ?

9.3 Testing Undertaken

The video interview of Arnaud Huvet, scientist at Ifremer, was presented on a tablet at World Oceans Day in Paris, and was also put online on the ResponSEAble Youtube channel and used in posts on social media. The few people who actually watched the video notified us that they enjoyed it and learned something. However, most people did not watch the video seeing as the room was very noisy with a lot of echo, and the screen was small.

We also brought the posters to the Aquarium Tropical de la Porte Dorée in Paris during World Oceans Day and to Fête de la Science in Brest. In Paris, we were able to expose the posters more or less as one would for an exhibit. At the science festival however, the layout was not so poster-friendly: we had no other choice than to hang them on the back of the inside of our stand, with our table and the 'The Ocean and Me' game players in front.

9.4 Evaluation

As yet, we have not gathered any data, however, we have received a fair amount of feedback from visitors who saw/read the posters and videos at events.

At the Paris Aquarium Tropical de la Porte Dorée's Ocean Festival, the portrait posters appeared to be quite popular. The layout was far from perfect - they were so low that people had to bend over or stand on their knees to read them – but we still saw many people read them, and some came to tell us they enjoyed them. None accepted to reply to an assessment survey. At the Brest Science Festival, the layout was unfavourable to the posters and people could difficultly get close enough to read them. We saw many people, often young adults, take photos of the posters with their phones saying that they wanted to read them later. We managed to collect one survey. We were also approached by a local library that expressed interest in exhibiting the posters to their public in 2019.

We had some positive feedback about the video portraits at World Ocean Day and are currently working on an online survey that could be posted in the videos' description boxes, as to collect data.

9.5 Lessons Learned

The portraits collection and key actor approach to communicating a complex subject does make the issue appear more concrete and can help people find solutions while letting them know that some of the challenges in changing are "normal" – or at least that other people have had to deal with them too.

Interview videos do not seem to work well at events. Other organisations present at these events successfully used videos. Theirs were mainly visual, did not have much dialogue, and were presented on a big television screen, not a tablet.

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The main difficulty we faced with the posters was to find an adapted setting to exhibit them. We believe places like libraries, exhibit areas in events and aquaria would be more adapted than a stand already offering other activities. We also need to work on how to adapt the tool for diffusion via social media, as the posters are not yet adapted. The material (interviews, whether written or filmed) give a lot of material that can be adapted to different tools. The two formats we proposed now need to be refined and adapted to various diffusion canals, and we can create new formats from the interview material.

The portraits collection tool enabled us to showcase the viewpoints of actors and stakeholders of the issue, which is something many other tools cannot do. Readers can put themselves in someone else's shoes, discovering practical and concrete actions. It is an immersive format, which is popular at the moment.

This type of tool is adapted to target knowledge, awareness, attitude and behaviour. We chose to put emphasis on behaviour, while still highlighting the other aspects.

The diversity of the interviews can influence which audience will be interested.

The most important step in the creation of the portraits collection was to write an adapted and relevant interview guide. Choosing a semi-directive interview method gives the interviewee enough freedom to bring things up while keeping the interviewer in charge of the topics that are addressed.

Looking into when someone changes their behaviour and the difficulties they perceived gives a somewhat intimate take to the interview, so that the discourse and the "good practices" ideas do not always come from scientists and experts, but also from people "like you and me".

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10. Annex 6: Educational Tools for Children

The concept of the Zaza the mermaid workshop, her character, the narrative style of delivery and creative element was conceived by the Marine Foundation. The workshop content and factual data was developed with AZTI. Sustainable fishing strategy was developed with the help of Marine Stewardship Council. The design and delivery methodology was designed with Art 4 Space and developed following pilot workshops with the kids and children of a number of schools in London, England. With feedback both from the children and the kids a number of changes were made.

10.1 Ocean Literacy Objectives

Our aim was to provide the children with knowledge that the school curriculum would not teach and provide an environment to explore solutions and actionable behaviour.

For some OL Dimensions such as Attitude or Behaviour, sometimes it is difficult to identify the change we want to see (for example in countries when there is no sustainable food certificates, etc.) so we could discuss the importance of choosing clear and attainable behaviour changes The target audience is under 8 and therefore even harder to assess any behavioural change and we are only with them for under 2 hours. Our goal is to generate an emotional connection to the sea, cultivate enthusiasm and a love of the sea and the creatures that live it in. We can then educate about the negative things we do that damage the ocean having already established an interest and concern for the wellbeing of the creatures living it the sea. Together we explore how we can change this and what we can do. We also encourage then to share their new ideas with parents and adults and nurture a role as change makers in the youth of our culture.

10.2 Testing Undertaken

The workshop was implemented at a number of schools: Herbert Morrison School, St. Mark's Primary School and St. Christopher's School, London. Feedback from the teachers, children and art 4 space representative was then assessed and relevant changes made these were then re-tested on the new group. This was done 3 times in 3 different schools.

In Spain, the workshop was tested with children between 4-8 years old that attend the Ekoetxea, an environmental interpretation centre focused on biodiversity that lies at the heart of the UNESCO Biosphere site Urdaibai. Typically, parents living in the towns of Bermeo, Gernika and surrounding villages go to Ekoetxea to spend a few hours at Ekoetxea during the week-end. The workshop was conducted at three week-ends.

10.2.1 Method used to evaluate effectiveness

Here we document the questionnaires or other methods we used in evaluating the tools, and explain the purpose of the questions with respect to the objectives. An effectiveness questionnaire was created with the questions being asked during the workshop at pre allocated locations within the presentation. With each questionnaire we state the location and date, class age group and number of kids male and female.

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1. Who has visited the Beach this year? *(NB if you location is near the beach ask how many times they have visited and record results) / Show of hands yes? No?* This question is to establish a pre-existing relationship to the sea and whether this effects pre-existing knowledge
2. Zaza is happy when humans do good things for the sea. What are some of the things humans do that are good for the ocean? *Show of hands for each suggestion and ask two kids to raise their hands and get two kids to give their own suggestion. Protect the creatures in the sea / Learn about the sea Enjoy spending time in the sea* We like to maintain a positive framework for the kids to learn in and this question helps establish their existing knowledge
3. Do you know what some of the things humans do that are bad for the ocean? *Kids raise their hands. Ask five kids their suggestion. Write their answers down. Note - Please do not prompt with any ideas.* This is our way of assessing what the kids already know
4. What do you remember about Zaza and her adventure today? *Kids raise their hands. Ask five kids their suggestion. Write their answers down.* This question is our way of trying to establish if the workshop improve their knowledge and what information they retained
5. Make a promise to help protect creatures of the deep. *At the end the kids are asked to make promise. During a standing circle they each state this promise and then go write it down. The teacher records these promises.*

10.3 Lessons Learned

The kids love it the teachers love it. The cross-curricula approach is unique and with an increase in an interest in eco issues and yet no requirements in schools to teach this, the tool is welcomed. Also with art being removed and less time dedicated to creativity as the basis for new ideas, combining it with art activities is very successful. The audience is very young and therefore we found it challenging to write questions that fulfilled the evaluation effectiveness requirements and yet were not too complex for the kids. We also met some resistance from teachers as they felt it was pushing an agenda and they did not like that. Also getting this to scale up is challenging without a marketing budget.

With regards to the experience at the Spanish environmental centre, children enjoyed the workshop although it had to be shortened from its original design. Since these children were not in a classroom but doing a leisure activity, it was difficult to keep them for longer than one hour. We found that introducing elements which forced them to be active (pretending they were fishers, playing with waves, etc.) helped keep their attention. Additionally, since these children come from villages with a history of fishing, extra care was paid so that the take-home message did not blame the fishing industry in an obvious way.

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11. Annex 7. Surveys

Two approaches are documented here: surveys conducted by UBO and Océanopolis; and surveys conducted by NUIG.

11.1 Using JRASE as an opportunity to develop the assessment surveys for ResponSEAble Ocean Literacy Tools

Every year, Océanopolis aquarium organizes a project for students, from ages 6 to doctoral students, where classes work on an ocean-related subject with the help of scientists and experts while creating an artistic restitution of their scientific work. It is called “Jeunes Reporters des Arts, des Sciences, et de l’Environnement” (JRASE), or “Young Reporters of Art, Science and Environment. We shall refer to it as “JRASE” or “Young Reporters”. The project runs from in the middle of the school year to the end of May, when all the students present their work in front of other classes. As a group, the class chooses a subject they wish to work on for the rest of the school year. The themes vary greatly, including subjects such as biomimicry, marine pollution, or mass stranding for instance.

This created a good opportunity to develop and test Ocean Literacy assessment surveys all while assessing the effectiveness of using art (emotion and affect) and science (information) to change students’ perceptions of the ocean and making them more ocean literate.

11.1.1 Developing the surveys

To do so, we used the work done by Owen Molloy, Conor McCrossan and Matthew Ashley as a first base. They had provided a series of survey questions on each Key Story, as to enable comparisons with other assessments. The ResponSEAble project is oriented around 6 “Key stories”, or precise themes that it focuses on, such as microplastics in cosmetics, sustainable seafood, or eutrophication. We needed to include several Key Stories to have a broader approach (the JRASE project not being theme/story specific). The surveys would be sent out at the beginning of the classes’ participation in the project, and after their final restitution in May.

In January 2018, we developed assessment surveys that were adapted to 3 different school levels (from the French school levels “CE1”, approximately 7 years old to “Terminale”, around 17 years old). Matthew ASHLEY (Plymouth University), who piloted assessment within the ResponSEAble project, helped us determine the importance of the different questions, the organization of the surveys, and the response scales. Two high-school professors, the Océanopolis scientific mediation team (of 7) as well as a few school teachers advised us in what format and theme of question was adapted to each age group and on how to adapt vocabulary to ensure the students would understand the questions. Following their suggestions, we decided on 3 distinct surveys:

- One that was adapted to school children (“CE1” to “Sixième”, so from 7 to 12 years old approximately);
- One survey for middle schoolers (“Cinquième” to “Troisième”);
- And the last survey for high school students and adults (from “Seconde” on up, or 15 and over).

11.1.2 Testing the survey

Beginning February, we sent out the surveys to 20 teachers. 8 classes (or 271 students) responded to the “Before” survey and 4 classes (or 68 students) responded to the “After” survey. Teachers had trouble fitting the survey into their already very busy school-year, especially if one has to do it twice. Also, the timing of the “After” survey seems to have been problematic: the end of year “JRASE” restitution was from the 28th of May to the 1st of June, which is nearly the end of the school year for some grade levels, and is right before exams start for other grade levels, making it even more strenuous for teachers to find time for the survey. All 4 classes that responded both to the “Before” and “After” surveys were primary schools – with one class from each grade level (CE1, CE2, CM1 and CM2).

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During the week of restitutions, we were able to discuss with 3 of the 4 teachers, all of whom saying their students enjoyed being able to give their opinion, and that this was a constructive experience. One even exclaimed: “I cannot wait to start again next year!”, to which we were obliged to reply that this assessment – at least within the ResponSEAble project – was a one-time event.

11.1.3 Use

Thanks to the surveys we had already developed, we were able to create one topic specific survey (microplastics) and one general Ocean Literacy survey that were adapted to a general public as of 10 years old and that could be filled in fairly quickly, giving us a higher return rate than previously.

11.2 Ocean Literacy surveys of university students

The measurement of Ocean Literacy (OL) includes the measurement of the knowledge possessed by people in relation to an OL topic, and their attitude and behaviour towards that topic. In this research, 3 OL surveys were created to measure the level of OL possessed by groups of students in a 3rd level institution. The topics which the 3 OL surveys focused on are microplastics, coastal tourism, and sustainable fisheries. The knowledge, attitude and behaviour questions in the 3 OL surveys are based on surveys created as part of the ResponSEAble project. The results show that the students have a high level of pro-ocean-environmental attitude, their existing behaviour is low to medium, and their future intended behaviour is at a higher level than their existing behaviour. A statistically significant correlation exists between attitude and behaviour, but we did not find a statistically significant correlation between knowledge and either attitude or behaviour. The results of the data analysis provide information on how the content of the 3 OL surveys can be improved.

11.2.1 Methodology

The 3 OL surveys created as part of this research are based on the key story topics Microplastics, Coastal Tourism and Sustainable Fisheries. Each of the surveys contain the following 5 sections: (i) general respondent information e.g. country, city, age range, (ii) questions related to the knowledge possessed by the respondent regarding the OL topic, (iii) questions on the attitude of the respondent towards the topic, (iv) questions on the current behaviour of the respondent in relation to the topic, and (v) the future intended behaviour of the respondent in relation to the topic.

11.2.2 Knowledge Questions

The knowledge questions contained in the OL surveys are based on the knowledge questions created for the serious game which was developed as part of the ResponSEAble project, and information contained in the ResponSEAble key story documents. The questions are single or multiple choice questions and some of them have images associated with them. The sub-topics covered by the microplastics knowledge questions include possible ways for plastics to enter the ocean, micro-plastic face wash ingredients, and percentage of rubbish from single-use plastic. The sub-topics covered by the coastal tourism survey include the function of an artificial rock barrier, countries which receive the largest number of visitors each year, and the main effects of coastal development. The sub-topics covered by the sustainable fisheries survey include the types of fishing, percentage of fish which comes from fishing versus aquaculture, the self-sufficiency of the EU in seafood, and the identity of fish species.

11.2.3 Attitude and Behaviour Questions

The attitude, current behaviour, and intended future behaviour questions are based on pre- and post-surveys which were developed to measure the effectiveness of the ResponSEAble project’s OL tools. The 3 attitude questions in each of the surveys require the respondent to rate their level of agreement or concern on a 10-point scale. The surveys have a general attitude question which requires the respondent to rate their level of agreement with a statement related to how

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worried they are about damage to the natural environment. The other 2 attitude questions in each of the surveys relate to the respondents' attitude towards issues related to the specific OL survey topic. The micro-plastic attitude questions relate to the problems caused by microplastics in the sea, and the benefit to the sea if people stopped using products containing microplastics. The coastal tourism attitude questions relate to the effects of coastal tourism on the marine environment, and the benefit to the marine environment and human health if people support sustainable tourism activities. The sustainable fisheries attitude questions relate to the effects of unsustainable fishing and aquaculture on the marine environment, and the benefit to the marine environment and fishing industry if people buy and eat sustainably produced seafood.

The surveys each contain 5 current behaviour questions which gather information related to the current behaviour of the respondent in relation to the OL survey topic. Respondents were asked to rate the level of their behaviour, on a 10-point behaviour scale, in relation to the survey topics. The sub-topics for the micro-plastic current behaviour questions include looking for products that use recycled and recyclable packaging, looking for products that do not contain microplastics, and support for shops and brands that don't sell products containing microplastics. The sub-topics for the coastal tourism current behaviour questions include when the respondents are on holiday do they separate litter for recycling and do they look for businesses that reduce their negative impact on the environment, and when planning a holiday do they look for towns or resorts where council officials have introduced schemes to reduce negative impacts from tourism. The sub-topics for the sustainable fisheries current behaviour questions include the use of sustainable seafood guides and looking for information on which seafood to eat, asking for information in shops on the source of seafood and if it is sustainably sourced, and supporting campaigns that tell people to eat seafood that is sustainably sourced.

The surveys each contain 5 future behaviour questions which are future versions of the current behaviour question. They ask the respondent about what they will do in the future in relation to the OL survey topics. An example of a statement used in one of the current behaviour question is "I look for products that use recycled and recyclable packaging" and the future behaviour version of that question is "I will look for products that use recycled and recyclable packaging".

11.2.4 Gathering Data

The surveys were created and administered online using Google Forms. Google forms provide a way of creating and administering online surveys, and receiving and analysing the responses to the surveys. Bitly[4] links were used to provide access to the surveys and we surveyed undergraduate university students.

11.2.5 Data Analysis and Results

The responses received were analysed using Descriptive data analysis, Rasch analysis, and Correlation analysis. The descriptive analysis of the data gathered reveals the numbers of questions answered in relation to the 3 topics, the percentages of correct answers to the knowledge questions, the percentage of respondents who viewed the correct answers, and information on the levels of attitude and behaviour in relation to the survey topics. The Rasch analysis of the knowledge questions provides information on the relationship between the respondents' answers and the questions, the level at which each question measures the respondents' knowledge on the topic, how well each question fits with the dimensional topic being measured, and the error associated with the Rasch measurements. The correlation analysis of the responses provides information on the extent to which a respondent's attitude correlate with their behaviour, and on the internal consistency of questions in the survey that measure similar dimensions.

[4] https://bitly.com/

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11.2.6 Descriptive Analysis

There were a total of 184 responses: 70 to the microplastics survey, 69 to the coastal tourism survey, and 45 to the sustainable fisheries survey. Figure 11-1 shows a histogram of how the respondents performed on the microplastics knowledge questions.

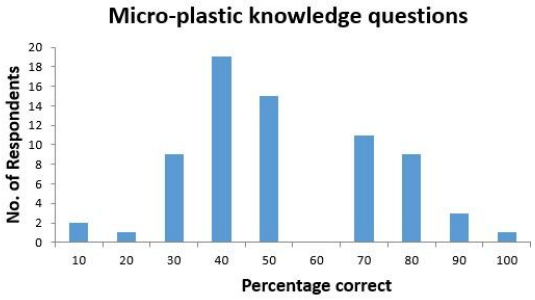

Figure 11-1: Respondents performance on the microplastics knowledge questions

The mean value for correct answers in the micro-plastic knowledge responses was 48.93% and the standard deviation was 20.49. Figure 11-2 shows a histogram of how the respondents performed on the coastal tourism knowledge questions.

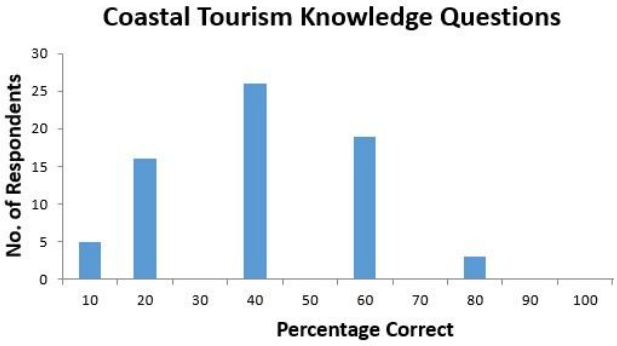

Figure 11-2: Respondents performance on coastal tourism knowledge questions

The mean value for correct answers in the coastal tourism knowledge responses was 39.71% and the standard deviation was 19.85. Figure 11-3 shows a histogram of how the respondents performed on the sustainable fisheries knowledge questions.

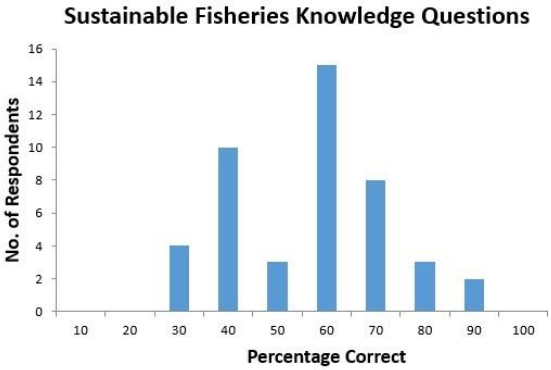

Figure 11-3: Respondents performance on sustainable fisheries questions

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The mean value for correct answers in the sustainable fisheries knowledge responses was 51.85% and the standard deviation was 17.73.

17 of the 70 respondents to the microplastics survey used the link to view the microplastics correct answers, 9 of the 69 respondents to the coastal tourism survey used the associated correct answers link, and 13 of the 45 respondents to the sustainable fisheries survey used the associated correct answers links. So, the percentage of respondents who used the associated correct answers links for the microplastics, coastal tourism, and sustainable fisheries was 24.3%, 13%, and 28.9%, respectively.

11.2.7 Correlation Analysis

The correlation analysis of the relationship between attitude and behaviour in relation to the surveys shows that a correlation does exist. The Pearson correlation r-value for the correlation between attitude and behaviour for the microplastics responses was found to be 0.495 with the correlation significant at the 0.01 level (2-tailed). The r-value for the correlation between attitude and behaviour for the coastal tourism responses was found to be 0.442 with the correlation significant at the 0.01 level (2-tailed). The r-value for the correlation between attitude and behaviour for the sustainable fisheries responses was found to be 0.296 with the correlation significant at the 0.05 level (2-tailed). No statistically significant correlation was found between knowledge and attitude or knowledge and behaviour for each of the 3 OL surveys.

The internal consistency of the questions used to measure the attitudes and behaviour of respondents was measured by performing correlations between each of the questions measuring attitude and each of the questions measuring behaviour. A statistically significant correlation was found for all of the pairings except for the pairing between microplastics behaviour questions 15 and 16, and the pairing between sustainable fisheries attitude questions 11 and 12.

11.2.8 Reliability Analysis

The Cronbach's alpha statistical test was used to check the internal consistency of the attitude and behaviour questions. The resulting Cronbach's alpha value for the attitude questions in the survey on microplastics was 0.783, coastal tourism was 0.8, and sustainable fisheries was 0.604. The Cronbach's alpha value for the behaviour questions in the survey on microplastics was 0.808, coastal tourism was 0.869, and sustainable fisheries was 0.873.

11.3 Rasch Analysis

Person abilities are calculated by performing a log odds (logit) transformation on the percentage of questions a respondent has answered correctly (Bond and Fox, 2007). For example, to calculate the logit value for a percentage correct score of 64%, we calculate the odds of 64 to 36 by dividing 64/36, and then get the natural log of the result, which is +0.58 logits. The item difficulties are calculated similarly and are based on the percentage of times a question is answered correctly. The error value is an indication of the accuracy of the Rasch measure for a person ability or item difficulty and the error values are related to how many items or persons are positioned in the same area on the Rasch logit scale. The fit value for items is an indication of the extent to which a question appears to be measuring the unidimensional topic and the fit for a person can give an indication of unusual sequences of responses e.g. a person guessing the answers to questions. One of the types of fit reported by Rasch analysis is "Outfit", which can indicate if a person's responses are unexpected with respect to that person's ability (Fauville et al., 2018). The "Outfit Zstd" values reported in tables 4, 5, and 6 are standardized fit statistics which are the result of t-tests of the hypothesis "Does the data fit the model (perfectly)?" (Outfit, 2018).

The Rasch analysis of the knowledge questions in the surveys was performed using Winsteps (2018). The Winsteps software package allows Rasch person ability, item difficulty, error, and fit information to be calculated from responses to a set of questions. Tables 4, 5, and 6 show the Rasch estimates for the knowledge questions in the surveys. The tables

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are ordered by question difficulty with the most difficult question at the top. The “Question Text” column shows the text of the question used in the OL survey. The “Total Score” column contains the number of respondents who answered the question correctly. The “Measure” column contains the logit value which gives an indication of the difficulty of the question. The “Standard Error” column shows the error related to the Rasch measurement and the “Outfit Zstd” is the level of fit associated with the Rasch measurement.

11.4 Current and Future Behaviour

Figure 11-4 shows a double line graph based on the responses to the microplastics current behaviour and future behaviour questions. The horizontal axis contains numbers related to each of the respondents and the vertical axis is the score related to the respondents’ current and future behaviour. The light grey line is a plot of the respondent scores for current behaviour and the dark grey line is a plot of their scores for future behaviour. The line for future behaviour is generally above the line for current behaviour which shows that in general the respondents intend to improve their behaviour in the future. This general trend is also reflected in the current and future behaviour responses in the coastal tourism and sustainable fisheries OL surveys.

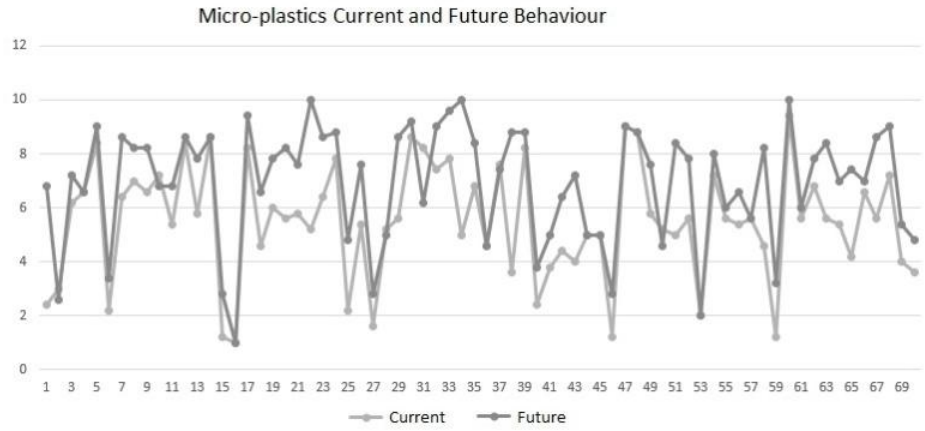

Figure 11-4: Microplastics current and intended behaviour

11.5 Distractor Analysis

The distractor analysis on the responses to the surveys was performed by identifying the knowledge questions in the surveys that required the respondent to choose a single answer from a list of options, calculating how many times each option was chosen, and checking if the resultant values indicated that the option was chosen more times than the correct answer or less than 5% of the time. 4 of the knowledge questions in the microplastics survey, 2 of the coastal tourism knowledge questions and all 9 of the sustainable fisheries question had their distractors analysed.

11.6 Discussion

The results of the descriptive analysis show that the OL survey respondents have a slightly higher level of knowledge about sustainable fisheries (mean 51.8%) when compared to knowledge of microplastics (mean 48.9%). The level of knowledge possessed by the respondents with regard to coastal tourism is the lowest at 39.7%. The respondents to the sustainable fisheries survey have the highest percentage (28.9%) for viewing the correct answers to the knowledge questions, followed by the percentage (24.3%) of respondents who viewed the correct answers to the microplastics knowledge questions, and the percentage who viewed the correct answers to the coastal tourism knowledge questions is the lowest at 13%.

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The mean scores for the responses to the attitude questions in the 3 OL surveys are similar with the attitude score for microplastics the highest at 8.29, followed by sustainable fisheries at 8, and coastal tourism with the lowest at 7.5. The mean scores for the current behaviour responses were highest for microplastics (5.5), followed by coastal tourism (4.5), and sustainable fisheries had the lowest mean score (3.7). The mean scores for future behaviour are all higher than the scores for current behaviour with the score for microplastics (6.9) the overall highest, and similar mean scores for sustainable fisheries and coastal tourism at 5.8 and 5.7, respectively.

11.7 Correlations

A medium correlation was found between attitude and behaviour for the responses to the surveys. The Pearson correlation r-value of 0.224 found by Yoon Fah and Sirisena (2014) for the relationship between environmental attitudes and environmental behaviours is slightly lower than the r-value of 0.296 found in this research for the relationship between attitude and behaviour with regard to sustainable fisheries. The r-values for attitude and behaviour for the microplastics and coastal tourism surveys are higher at 0.495 and 0.442, respectively. Michalos et al. (2017) found an r-value of 0.35 for attitudes and behaviour towards sustainable development which is a slightly higher than the r-value found in this research for the same relationship related to sustainable fisheries. One of the behaviour questions in our sustainable fisheries OL survey relates to supporting campaigns that tell people to eat seafood that is sustainably sourced. Adding a related attitude question asking people what their attitude is towards such campaigns could improve the overall correlation between the attitude and behaviour questions in the sustainable fisheries OL survey.

The reason why no significant correlation was found between knowledge and attitude or knowledge and behaviour could be related to the quality of the questions. If the knowledge questions were more aligned with measuring knowledge related to the specific topics being measured in the attitude and behaviour questions, a significant correlation may exist. One of the coastal tourism attitude questions measures how worried respondents are about the effects of coastal tourism activities on the marine environment. Adding a knowledge question to the OL survey which tests a respondent's knowledge related to coastal tourism activities may improve the correlation between knowledge and attitude. An example of such a question would be "How does the activity of cleaning seaweed from a beach impact the coastal environment?" Care should be taken to ensure that aligning the knowledge questions with the attitude and behaviour question will not constrain the measurement too much and will not create questions that are too difficult for the respondents to answer correctly.

11.8 Reliability

The Cronbach's alpha values for the attitude and behaviour question in the surveys shows an acceptable to good reliability except for the attitude questions in the sustainable fisheries OL survey. The Cronbach's alpha value for the attitude questions in the sustainable fisheries OL survey was 0.604. This value could be increased to 0.744 if attitude question 12 was removed from the survey, as shown in table 3. Question 12 in the sustainable fisheries OL survey is related to both the benefit to the marine environment and the fishing industry of buying and eating seafood that is labelled sustainable. This question could be improved by dividing it into 2 questions, one which relates to the benefit to the marine environment and another which relates to the fishing industry.

11.9 Rasch Estimates

The Rasch analysis of the knowledge questions (Table 11-1) in the microplastics OL survey shows that the most difficult question was question 5 "Select products which might have contained micro-beads in the past" and the least difficult question was question 7 "Where does the majority of our plastic waste end up?". The respondents and questions are grouped towards the centre of the logit scale in the Rasch person-item map which indicates that the questions are not measuring the upper and lower respondent abilities. The Rasch person-item map provides a visual representation of the

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positioning of person abilities and item difficulties in relation to each other along a vertical logit scale (Bond and Fox, 2007). The error associated with each of the questions is low due to the fact that there are a lot of respondents grouped at the same logit level as the questions. The Oufit Zstd value for question 2 is 4.0 which is well outside the acceptable range of -2 to 2. This means that question 2 does not fit with the unidimensionality of the microplastics OL survey. Question 2 is "Which of the face wash ingredients shown might be microplastics? An image and a list of options to choose from are provided to the respondent. The correct answer to the question is a single option but the format of the question allowed the respondent to choose multiple options. This may explain why question 2 had poor fit in the Rasch analysis. To improve the fit of this question the format of the question could be changed to only allow the respondent to choose one option. The rest of the knowledge questions in the microplastics OL survey have Oufit Zstd values which are within the acceptable range. Improving the set of micro-plastic knowledge questions, with a view to making them a more effective scale to measure the levels of OL possessed by respondents, would involve creating more knowledge questions that are more difficult and less difficult. These new questions could be combined with the existing questions, the survey could then be administered to another cohort, and Rasch analysis could be used to check the improvement of the questions as a scale to measure OL in relation to micro-plastic knowledge.

The Rasch analysis of the coastal tourism knowledge questions (Table 11-2) shows that the most difficult question is question 3 "Please choose the main effects of coastal development from the list below" and the least difficult question is question 1 "The picture below shows a paradise beach in the middle of summer. There is an artificial rock barrier in front of the beach. What is the function of the artificial rock barrier?" The person-item map shows that the questions are spread out along the logit scale with questions 2, 5, and 1 measuring ability below the zero logit point and questions 3 and 4 measuring abilities above the zero logit point. The zero logit point on the logit scale is the mean point of the item difficulty estimates (Bond and Fox, 2007). The error associated with the Rasch measure for each of the respondents is larger than that error associated with the items which is due to the fact that there are only 5 coastal tourism knowledge questions and they are spread out along the logit scale. To increase the effectiveness of the coastal tourism knowledge questions, more knowledge questions could be created to measure the levels of knowledge in between the existing knowledge questions. As well as being the least difficult question, question 1 is also the question with an Outfit Zstd value of 2.9 which is outside the acceptable range of -2 to 2. The reason question 2 does not appear to fit with the measurement of respondents' knowledge related to coastal tourism may be due to the fact that question 2 is a question more related to coastal erosion than coastal tourism. To improve the fit of this question, it would need to be changed to focus more on coastal tourism.

Table 11-1: Rasch estimates for micro-plastic survey knowledge questions

Question Text	Total Score	Measure	Standard Error	Outfit Zstd
Q5. Select products which might have contained micro-beads in the past:	17	1.34	0.31	-1.0
Q4. Sunlight can degrade plastics in the ocean: true or false?	31	0.23	0.27	-0.3
Q3. What percentage of ocean rubbish do you think comes from single-use plastic (things that were only used once and then thrown away)?	32	0.15	0.27	-0.5
Q1. Select all which you think are possible ways for microplastics to enter the oceans:	33	0.08	0.27	-1.4
Q8. The equivalent of one rubbish truck of plastic waste is being added to the sea every...?	34	0.01	0.26	1.7
Q2. Which of the face wash ingredients shown might be microplastics?	37	-0.20	0.26	4.0

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Q6. Why is plastic dangerous for marine life?	38	-0.27	0.27	-1.3
Q7. Where does the majority of our plastic waste end up?	52	-1.35	0.30	-0.5

The Rasch analysis of the sustainable fisheries knowledge questions (Table 11-3) shows that the most difficult question is question 1 "What is the kind of fishing shown in the image below?" and the least difficult question is question 5 "The picture below shows a cod (*Gadus morhua*) fish. Where does the cod species live?" The person-item map for the sustainable fisheries knowledge questions shows that most of the questions are grouped below the zero logit point which means that they are providing measurements of respondents with medium to low knowledge levels. Questions 1 and 8 are the only questions above the zero logit point. Improving the set of sustainable fisheries knowledge questions as a scale to measure OL knowledge related to sustainable fisheries would involve creating more knowledge questions to measure those respondents with medium to high knowledge related to sustainable fisheries. The positioning of the respondents with medium to high knowledge of sustainable fisheries has a larger error than the positioning of those with medium to low knowledge. This is due to the fact that there are less questions in the medium to high knowledge section. The "Outfit Zstd" value for question 9 is 2.1 which is just outside the acceptable range for fit. Question 9 relates to the percentage of the global population that depends on the ocean for food. A way of attempting to improve this question could involve adding more specific information to the wording of the question.

Table 11-2: Rasch estimates for coastal tourism survey knowledge questions

Question Text	Total score	Measure	Standard Error	Outfit Zstd
Q3. Please choose the main effects of coastal development from the list below:	3	3.01	0.62	-0.4
Q4. The image below shows a beach backed by dunes. Dunes are a vital component of coastal systems. Why are dunes so important to the coastal environment?	18	0.59	0.31	0.7
Q2. Which countries receive the largest number of visitors on a yearly basis? Please select 3	32	-0.60	0.28	-0.1
Q5. Since 1995, international tourism in the Mediterranean basin has grown by almost:	32	-0.60	0.28	-1.6
Q1. The picture below shows a paradise beach in the middle of summer. There is an artificial rock barrier in front of the beach. What is the function of the artificial rock barrier?	52	-2.40	0.35	2.9

Table 11-3: Rasch estimates for sustainable fisheries survey knowledge questions

Question Text	Total Score	Measure	Standard Error	Outfit Zstd
Q1. What is the kind of fishing shown in the image below?	2	3.59	0.76	-0.2
Q8. Which European country eats the most fish and seafood per capita?	14	0.91	0.36	0.7

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Q7. The image below shows an Albacore Tuna (*Thunnus alalunga*). At what age does the Albacore Tuna reproduce?	23	-0.11	0.33	1.0
Q2. What percentage of the fish consumed in the EU comes from fishing and aquaculture?	25	-0.33	0.33	-0.2
Q9. What percentage of the global population depends on oceans and seas for food?	25	-0.33	0.33	2.1
Q4. What type of fishing technique is shown in the image below?	27	-0.55	0.33	-0.6
Q6. Which species is shown in the image below?	29	-0.77	0.34	-0.7
Q3. Is the European Union self-sufficient in seafood?	31	-1.01	0.35	0.3
Q 5. The picture below shows a Cod (*Gadus morhua*) fish. Where does the Cod species live?	34	-1.40	0.37	-0.3

11.10 Question Distractors

The distractor analysis of the microplastics knowledge questions indicated that questions 4 and 7 could be improved. Question 4 is “Sunlight can degrade plastics in the ocean: true or false?” More respondents chose the incorrect (false) answer than the correct answer. This question could be improved by adding a third option to allow the respondent to indicate if they are unsure about the answer. Question 7 is “Where does the majority of our plastic waste end up?” and less than 5% of respondents chose the options “Burned for energy” and “Recycled”. This question could be improved by removing these answer options and possibly adding in an option which would successfully attract respondents who are unsure about the correct answer. Similarly, 2 of the coastal tourism knowledge questions and 6 of the sustainable fisheries knowledge questions had distractors which were chosen less than 5% of the time. Each of these questions would benefit from a review of their distractors with a view to removing options which do not sufficiently distract unsure respondents.

11.11 Conclusion

A person’s level of knowledge on an OL topic, and their attitude and behaviour towards that topic are important dimensions of their level of OL in relation to that topic. The most commonly used way to effectively measure a person’s OL is to ask them to respond to questionnaires or surveys on topics related to the ocean. There were 3 OL surveys created in this research which measure respondent’s knowledge, attitude, and behaviour related to the OL topics of microplastics, coastal tourism, and sustainable fisheries. The data from responses to the questionnaires was used to measure the level of OL possessed by the respondents and it was also used to indicate how the questionnaires and surveys might be improved. In this research, the level of knowledge possessed by the students on microplastics, coastal tourism, and sustainable fisheries was found to be slightly below medium. A statistically significant correlation was found between attitude and behaviour for the 3 OL topics, but no significant correlation was found for the relationship between knowledge and attitude or behaviour. The use of Cronbach’s alpha analysis, Rasch analysis, and distractors analysis has provided results which can be used to improve the effectiveness of the 3 OL survey questions.

In future research, it would be useful to apply the results of the data analysis to a review of the contents of the surveys with a view to improving the questions, so that the responses to the knowledge questions will correlate with the respondent’s attitude and behaviour towards the OL topics. The improved questions could then be used as a scale to measure the respondent’s levels of OL in relation to the topics. The information required by a respondent to answer the questions on the knowledge scale could then be incorporated into the existing OL tools created as part of the ResponSEAble project. SEM and CFA could be used as part of the process of improving the OL survey questions by

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creating a model of which types of knowledge related to a topic are factors in the level of pro-ocean-environmental attitude and behaviour possessed by respondents. For example, in relation to the sustainable fisheries survey, is a person's ability to identify species of fish a factor in the level of concern they have in relation to the effects of unsustainable fishing?

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12. Annex 8: A series of 6 x 5-minute films

12.1 Overview of the Design and Development Approach

The films have been designed in terms of editorial format and style to engage a range of different audiences through a variety of different online web platforms and media channels and to have the capability to serve different communication purposes: to be commissioned or acquired by an online media channel, to feature on a more specialised stakeholder website; to be disseminated through social media, to be screened at a seminar or to be relevant for classroom or university use.

In addition the editorial approach and narrative structure of the films are intended to incorporate principles that work well in behaviour change campaigns:

- give the audience an incentive;
- keep the story or message positive;
- use stories to convey the ideas and information;
- demonstrate social influence – that influential individuals have adopted the behaviour.

Our final design consideration was that not only do the films have to appeal to a target audience, they also have to appeal to commissioners and editors who control the content of media channels and web platforms. These could be industry or policy stakeholders, online news and information channels or educational content providers or other information aggregators. All these categories of commissioners have to know that the content they are featuring is produced to the highest journalistic standards – i.e. which is factual, authoritative, balanced, and transparent – as well as engaging.

The Key Stories identified certain specific audiences as follows:

Films	**Specific audiences identified by Key Stories**
Coastal Tourism	Tourists / General public
Eutrophication	High School / University Students / General public / consumers
Invasive Species	Shipping Industry / General Public / news outlets
Marine Renewable Energy	MRE Investors / Coastal communities / General Public / news outlets
Microplastics	General public / news outlets
Sustainable Fisheries	General public / news outlets

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12.2 Ocean Literacy Objectives

The following table shows the OL objectives defined for the key stories and relevant actors targeted.

Target group	Ocean Literacy Goals
Coastal Tourism Coastal tourists General public	• Raise awareness on impact mass tourism • Encourage tourists to support or choose more sustainable activity in region • Inspire people with positive stories and examples sustainable best practice
Eutrophication Secondary level (school) and tertiary level (university) students General public / consumers	• Increase knowledge of Eutrophication process and complexity. • Increase understanding of Individual meat consumption as a driver for Eutrophication
Invasive Alien Species Shipping Industry General public Young people (education)	• Raise awareness of Invasive Alien Species (IAS) • Encourage uptake of ballast water filtration technology showcase best practice
Marine Renewable Energy (MRE) General public Young people (education) MRE investors	• Encourage more informed public debate • Convey state-of-the art knowledge on the effects of MRE on biodiversity and show how planning and design and collaborative approaches between industry and marine ecologists can protect the natural environment. • Encourage investment in MRE • Inform coastal communities of the economic benefits and environmental sustainability of MRE • Reach public through media channels and other multipliers
Microplastics General public, young people	• To reach public through media channels and other multipliers • To convey the complexity of micro plastics issue and the interaction between science, communications and cultural activities; • To convey rising public awareness and dynamic public perceptions, opinions and movements coalescing around this issue
Sustainable Fisheries General public /Consumers	• Encourage more informed public debate by clarifying sustainable fishery certification scheme and about fisheries co-management • Show how collaborative approaches between aquaculture and natural science community can lead to more environmentally sustainable fish production and reduce impact on wild stocks. • Reach public through media channels, and other multipliers

12.3 Testing Undertaken

Two different models of testing were applied across the film series. Testing has not been applied to all of the six individual films and not all of the testing has yet been fully analysed. The testing detailed below is therefore indicative.

12.3.1 Testing Model 1. Formal face to face pre and post-viewing surveys

The mode of testing and questions for formal pre and post viewing surveys were developed by Dr Matthew Ashley at Plymouth University. The following formal surveys have been carried out:

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Location	Audience type / group	Films tested	Number of Participants
Plymouth Aquarium UK	School children – 12- 15 years old	Rethinking Plastic	20
Durham University UK	Students	Rethinking Plastic	4
		Marine Renewable Energy	4
Exeter University, UK	Students	Rethinking Plastic	2
		Tackling Eutrophication	2
University Lusofona, Portugal	Students	Tackling Eutrophication	8
		Rethinking Plastic	9
		Sustainable Aquaculture	10
		Making Tourism Sustainable	8

12.3.2 Testing model 2: Online user feedback surveys, accessible online by viewers responding to questions post viewing

The mode of testing and questions for the online post viewing surveys were developed by **tve** and with supervision from Dr Matthew Ashley at Plymouth University. 26 online surveys have been completed by viewers of the films as follows:

Film	Completed online feedback surveys
Rethinking Plastic	7
Sustainable Aquaculture	6
Invasive Alien Species	0
Making Tourism Sustainable	4
Tackling Eutrophication	5
Marine Renewable Energy	4
Total	**26**

12.3.3 Testing Model 1 Approach: Formal pre and post viewing surveys.

Detailed analysis of one of the formal pre and post viewing surveys is provided below.

Film: 'Rethinking Plastic' inclusion in education events for 11-15 year old school students at National Marine Aquarium, Plymouth.

The short film '*Rethinking Plastic'* used interviews with leading academic experts, businesses and environmental charities and campaign groups that represent actors identified in the DAPSIWR causal model developed for the key story 'microplastics' (specifically microplastics in cosmetics) (ResponSEAble, 2015). The film provided clear messages on the drivers of microplastics production, the activities supporting their use and the pressures on the state of the marine environment that leads to negative impacts on the marine organisms, the environment and potentially human health and welfare. Responses were presented that can be undertaken by consumers, businesses, product manufacturers and local

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and national governments. It was designed to be appropriate for school students over 11 and general public of different ages, backgrounds, levels of knowledge and cultures. The film promoted specific actions viewers could take to reduce use and negative impact of microplastics in the marine environment. A total of 20 school students aged 12-15 years, participated in a viewing of the film '*Rethinking Plastic'* at an aquarium in Plymouth, UK and responded to survey questions before and after viewing. School students were recruited for the film viewing, from attendees of events run for UK teenagers as part of the aquariums 'teen club' Ocean Squad events. The week-long events are advertised nationally and participants can book on the aquarium website.

Method used to evaluate effectiveness

A shorter survey tool was used, with a smaller range of questions and simplified language than in surveys for general public (16+) and professionals, to make it more suitable for the younger sample. The questionnaire was completed with assistance of teachers and course leaders during an introduction session (pre) and again at the following day, after viewing the film (post). The questionnaire took about 10 minutes to complete.

The pre-course questionnaire included eleven questions designed to assess participants' awareness of the issue of microplastics entering the sea, general concern (for damage to the environment), knowledge, perceived understanding, concern (about effects of microplastics on marine life), belief and values, communication (social norm), and self-reported behaviours in relation to specific actions to help reduce or cope with the impacts of microplastics on the marine environment and human welfare. Further questions were designed to assess factors relating to participants' age, location, pre-existing concern for marine environmental issues and feedback on sources of information on environmental issues.

The post-course questionnaire included the same questions. Present tense was changed to future tense in relation to behaviour questions to assess participants' intended behaviour after completing the workshop.

12.3.4 Testing Model 2 Detailed Approach: Online viewer feedback surveys

With the films primarily viewed and shared online, a simplified feedback survey was developed to be embedded next to the viewing screen for each of the six films. The intention was to gather feedback from viewer responses to the films – especially whether viewers engaged favourably with the film format and whether the viewers felt that viewing the film was likely to result in a change in their own behaviours with regard to the information and messages contained in each film.

12.4 Presentation of the evaluation data & feedback gathered.

12.4.1 Testing Model 1. Formal face to face pre and post-viewing surveys

Summary of data gathered for Survey on Rethinking Plastic

Pre and post survey responses were used to assess if objectives within the Theory of Change for the 'Rethinking plastic' film presented within the NMA activities had been met (Table 12-1, Figure 12-1). After viewing the film and participating in the activities, participants self-reported knowledge about i), how microplastics effect marine life and ii), how microplastics may affect human health, had significantly increased (marine life $t(15) = 4.7$, $p < 0.005$, $d=5.99$, human welfare $t(15) = 3.49$, $p < 0.005$, $d=4.6$) (Figure 12-1). Before the course 71% of participants answered the knowledge question 'How long does a plastic bottle take to degrade in the ocean? After the course 75% of participants answered the question correctly.

Participants pre-existing concern for damage to the natural environment and concern for the effects of microplastics on marine life was high at the start of the study (natural environment, mean 8.7 SE± 0.3, effects of microplastics, mean 8.25 SE± 0.34). Concern remained high or showed a small increase after the viewing the film, a small to moderate positive effect size occurred for concern for effects of microplastics (concern about damage to the environment $t(16) = 0.06$, p 0.48, $d=0$, concern about effects of microplastics $t(15) = 1.36$, p 0.1, $d=0.75$). Participant's level of agreement with the

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statement that, 'I believe there will be a benefit to the health of the sea and people's health if I stop using products containing microplastics,' was also high before viewing the film (mean 8.4 SE± 0.38) and showed a small increase and medium positive effect size after the event (t(14) = 3.5, p = 0.05, d = 1) (Figure 12-1).

Self-reported frequency of communication with friends, family and colleagues about ,'ways of helping to reduce the problems microplastics may cause in the sea.' showed an increase after the course t(16) = 1.82, p = 0.04, d=1.2 (Figure 12-1).

After completing the course, the participants who were attending the event from across the UK, reported a strong intention to frequently undertake all actions to: 'help reduce the effects of microplastics on the marine environment in the future'. Self-reported frequency of undertaking the action: 'separating plastics for recycling' was already high (mean) in the pre intervention survey, and there was still a small increase in frequency participants intended to undertake this action in the future t(14) = 0.73, p = 0.24 d=0.84. Before the event, participants reported a moderate frequency of 'looking for products that use packaging that can be recycled' (Mean 5.8 SE ± 0.61) and after the event a greater frequency of undertaking the action was intended (mean 7.0 SE ± 0.69) although with Bonferroni correction the change was not significant t(16) = 2.05, p = 0.03, d=1.84 (Figure 12-1). Significant increases occurred in frequency participants reported they would undertake the actions 'looking for products that don't contain microplastics', and, 'supporting shops that don't sell products containing microplastics' (look for products t(16) = 4.89, p = 0<0.005 d=4.43, supporting shops, t(16) = 4.49, p = <0.005 d=3.53) (Figure 12-1).

Table 12-1 Summary of results of pre and post surveys in relation to objectives in the theory of change related to participants' viewing the 'Rethinking Plastic' film.

	Problem Awareness / Knowledge	**Knowledge**	**Attitude (concern)**	**Attitude – (belief in benefit from own action (self efficacy))**	**Interpersonal Communication / Social Norm**	**Behaviour Change**
Objective	i) After the course, mean response of participants who watch the video and take part in activities, to the statements: *'I have good knowledge about how microplastics effect native marine life and how microplastics may affect human health?'* (0-10 scale) will be ≥7. ii) If mean pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	After the course, ≥75% of course participants will correctly answer the Ocean Literacy knowledge quiz question (time in years a plastic bottle takes to degrade in the sea).	i) After the course mean response of participants to the question, *'how worried are you about the problems microplastics in the sea might cause?'* (0-10 scale) will be ≥7. ii) If mean pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	i) After the course, mean response of participants to the statement: *'I believe there will be a benefit to the health of the sea and people's health if I stop using products containing microplastics,'* (0-10 scale) will be ≥7. ii) If mean pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	i) After the course, mean response of participants to the statement *'How often do you talk about ways of helping to reduce the problems microplastics may cause in the sea with your family, friends, colleagues or teachers'* (0-10 scale) will be ≥7. ii) If mean pre course response is <7, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5).	After the course, mean response of participants will be ≥7 for at least 2 intended behaviour options to *'help reduce the effects of microplastics on the marine environment in the future,'* ii) If mean pre course response is <7 for the options, effect size (Cohen's *d*) will show a medium or greater positive effect (≥0.5) for at least 2 options.

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Result	i), Mean response post (environment) = 8.3 (SE± 0.4) (welfare) = 7.5 (SE± 0.5). Cohens *d* = 1.5 ii) Mean response pre (environment) = 4.7 (SE± 0.6) (welfare) = 4.9 (SE± 0.5) Cohens *d* = 1.7	Correct answer (post) = 73%.	i), Mean response (post) = 8.5 (SE± 0.4) ii) Mean response (pre) = 8.3 (SE± 0.4) Cohens *d* = 0.75	i), Mean response (post) = 8.8 (SE± 0.5) ii) Mean response (pre) = 8.4 (SE± 0.4) Cohens *d* = 1	i), Mean response (post) = 5.6 (SE± 0.6) ii) Mean response (pre) = 4.9 (SE± 0.5) Cohens *d* = 1.2	i), Mean response (post) = >7 for all behaviours ii) Mean response (pre) = between 4.1 and 7.5 across behaviour options. Cohens *d* = >0.8 (between 0.84 and 4.34) across all behaviour options.
Objective achieved? Yes/No	i), **Y**, ii), **Y**	iv) N	i), **Y**, ii), **Y** (all ready >7)	i), **Y**, ii), **Y** (all ready >7)	i), N, ii), **Y**	i), **Y**, ii) **Y**

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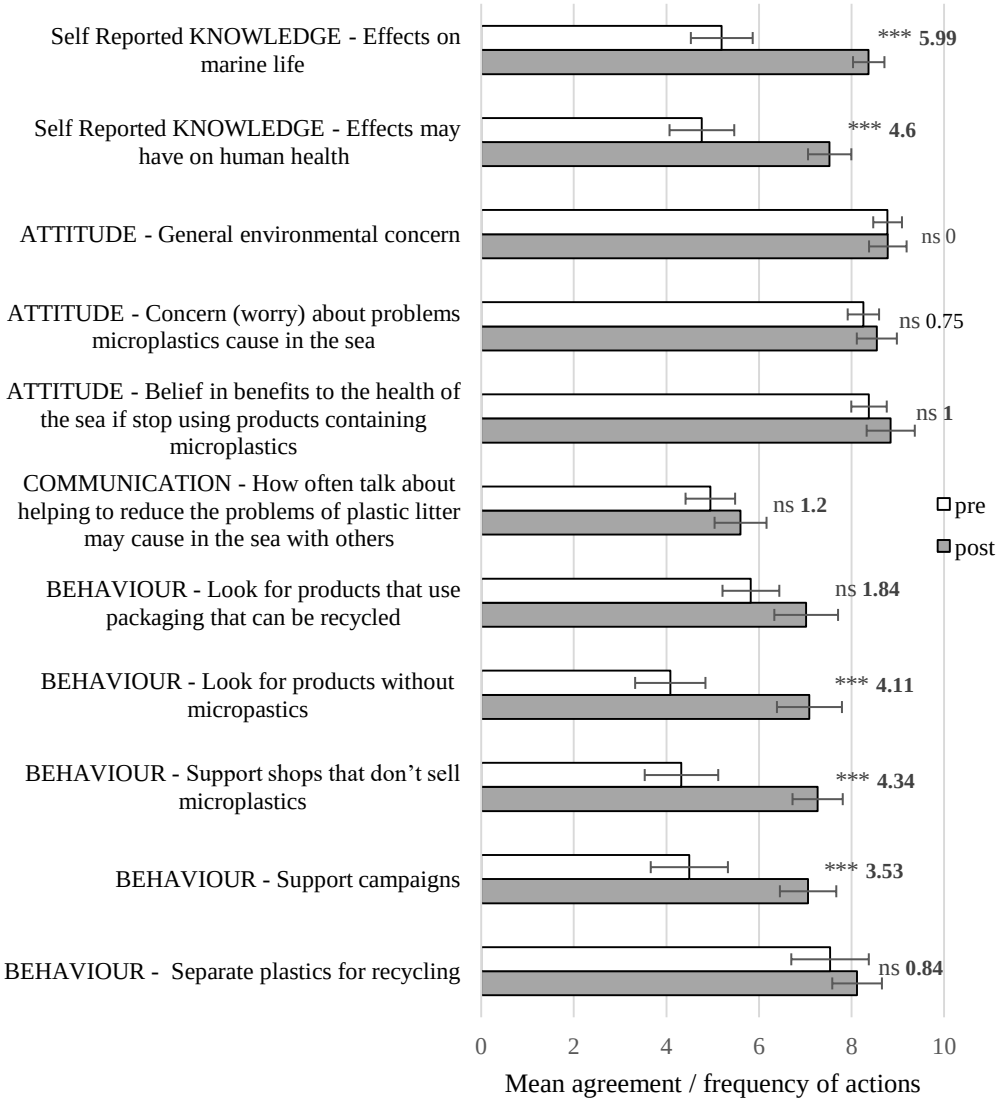

*Figure 12-1: Mean participant responses to pre and post surveys completed before and after viewing the 'Rethinking plastic' film, significant differences (p=<0.005) between pre and post surveys are indicated by ***, effect size (Cohen's d) of medium or above are in* bold(d=#).

12.4.2 Testing Model 2. Online viewer feedback surveys

Summary of data gathered for online surveys

As well as age and nationality, respondents were asked a range of questions, some common to all 6 films, some about each individual film, to assess the respondents understanding of ocean sustainability issues in general, the specific issue in each film, concern about the issue in each film, whether the respondent intended to discuss the issues with friends and family, what action the respondent felt they could personally undertake to help mitigate the issue and what actions they intended to undertake in future to help mitigate the issue.

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12.4.3 Testing Model 1- Key findings:

The students were a highly motivated group, with high initial levels of agreement with pro-environmental attitudes, such as concern for the effects of microplastics on the marine environment, and belief in benefits from taking action to reduce negative impacts. The student's self-reported frequency of current behaviours to reduce marine litter such as 'separating plastics for recycling' were already high.

Although only small increases in these attitudes and behaviours were seen, there were significant increases in self-reported knowledge on the topics in the film 'Rethinking plastic'. There was also a significant increase between current frequency of taking actions to reduce the use of products containing micro plastics and intended frequency following the course.

The film met Ocean Literacy objectives for the target audience, interestingly the film appeared to provide new knowledge to the group, specifically of causes of micro-plastic pollution and actions that could be taken to reduce the impacts of microplastics through reducing use of cosmetic containing them. There appears a benefit of showing the film, dedicated to raising awareness of specific actions, to a group that is already highly aware and motivated about marine issues as the specific behaviour responses identified in the film, to address the specific key story issues appear to have been picked up. *('Look for products that do not contain microplastics'* and *'Support shops that do not sell products containing microplastics*,').

12.4.4 Testing Model 2 - Key findings:

Summary of online survey post viewing responses to the films on what knowledge people have of the issues and their level of concern.

Rethinking Plastic

- Most people think they have good knowledge about how microplastics affect life in the ocean and sea.
- Most people have some knowledge about how microplastics in seafood coastal tourism activities may affect human health
- Most people extremely concerned about the effects of microplastics on the sea and ocean environment

Sustainable Aquaculture

- Most people think they have very good knowledge about how fishing and aquaculture effects the marine environment.
- Most people think they have very good knowledge about how sustainable activities can benefit fishing and aquaculture businesses.
- Most people are very concerned about the effects of unsustainable fishing or aquaculture on the sea and ocean environment

Sustainable Tourism

- Most people think they have quite good knowledge about how coastal tourism activities effect the ocean and sea environment
- Most people think they have quite good knowledge about how coastal tourism activities may effect human well-being"
- Most people extremely concerned about the effects of coastal tourism activities on the sea and ocean environment

Tackling Eutrophication

- Most people have good knowledge about how excess nutrients from the land effect the marine environment

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- Some people feel they have quite good knowledge about how the effects of eutrophication can affect human health and happiness
- Nearly all people are extremely concerned are you about the effects of excess nutrient in the sea and ocean environment

Marine Renewable Energy

- Most people have very good knowledge about how offshore wind farms effect marine life and sea birds.
- Most people have quite good knowledge about how offshore wind farm developments effect jobs and industry on the coast
- Almost all respondent were extremely concerned about the effects of climate change on the sea and ocean environment.

12.4.5 Summary of online survey post viewing responses to the films on what actions do people currently take, and what action they intend to take having viewed the film.

Rethinking Plastic

- People buy products that use recycled and recyclable packaging or look for sustainable alternatives about half of the time but 85% say they will in the future
- Most people rarely look for products that do not contain microplastics (such as some cosmetic products) but 100% say they will try to in the future
- People don't usually use shops and brands that reduce or remove products containing microplastics but most say they will try
- Most people don’t ask shops to reduce the amount of plastic products or products containing it and this won’t change much
- Most people are very good at sorting out their plastics recycling, but those that do not, don’t indicate that they will change

Sustainable Aquaculture

- People don’t always use sustainable sea food guides or look for information on which seafood to eat but all of them will try to
- Most don’t usually ask shops where the seafood they eat has come from, and half say they will
- More than half support campaigns that tell people to eat sustainable seafood
- People sometimes look for information on the sustainability of fishing and aquaculture used to produce my food and half will continue to do so
- People generally support projects and seafood producers that provide sustainable seafood and most will continue to do so

Responses came from a teacher running a vocational cooking class who showed the film to their students. They responded very well and were very interested in the information. They nearly all showed interest in changing their behaviour after watching the film.

Sustainable Tourism

- Most people always sort out their litter for recycling when on holiday on the coast and will continue to do so

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- Most people usually try to use companies that do not have a negative impact on the environment when on holiday on the coast and will try to do this in the future
- When planning a holiday on the coast some people look for places where local government have policies to reduce the negative effects of tourism and most will try to do this
- Most people usually look information on sustainable tourism activities that they can do in the areas they visit and will continue to do so
- Most people currently support projects to restore coastal and ocean habitats that have been damaged by coastal development and are keen to continue this

Responses came from two university lecturers who included the film part of their tourism courses. The groups responded very well to the information and students showed a strong interest in changing their behaviour after watching the film.

Tackling Eutrophication

- People rarely calculate the nutrient footprint of the food they buy and eat but more than half will try to change this.
- A few people are reducing the amount of meat and dairy they eat and eat more vegetables, most will not change their habits in this area
- Very few have used WWF meat guides or looked for information on which meat and dairy products to eat, but most will try to find out more information
- People do not generally look for information on the farming practices used to produce my food but most will look for more information
- A few people usually support projects and farmers that that reduce nutrients being washed into the sea and they all expect to do this in the future.

Marine Renewable Energy

- A few people think that offshore wind farms should not be developed because of uncertainty of environmental impacts
- Most people think that offshore wind farm developments greatly benefit employment and businesses in coastal areas
- People generally think offshore wind farms can benefit some fish and bird species
- People highly support offshore wind farms that are developed to reduce impacts on marine life and a few will support these in the future
- Almost everyone strongly supports energy suppliers that supply electricity from renewable sources including offshore wind and half intent to continue to support these suppliers

12.4.6 Summary of online survey post viewing responses to the films

We had 26 responses to the online survey, from people in 16 different countries with ages ranging from 18-54. The respondents found the survey through social media, and through searching for information on Ocean Literacy. Most respondents reported that they enjoyed the films, that they learned new information about the topics and that they would take affirmative actions

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13. Annex 9: Interactive Internet Platform

Details from the design and development approach have already been given in D5.7, but a summary of the process is given below.

The development of the interactive platform has been done in cooperation with NIVA, Seven Solutions and Grid-Arendal, led by NIVA. NIVA has invested in a total of 10 platforms (5 in the early part of 2018, and an additional 5 in late 2018). GDM (Global Digital Media, Stavanger) was contracted in late 2017 to deliver the “interactive engine”, the physical consoles, and hardware and some platform content. The main contributors to the content have been NIVA and Seven Solutions, but the platform includes tools developed by the ResponSEAble consortium.

The interactive internet platform has been developed for use in public places such as commercial ferries and cruise ships, museums and reception areas in research institutes. The requirements of the installation are power and internet access. If internet is not constantly available (which is the case for ferries), the platform defaults to static/offline content when no internet is available.

The interactive platform consists of a touch screen which is installed on a console, either a tilted screen or a screen embedded into a handmade birch wood platform shaped as a wave (Figure 13-1). The interactive content is available in four languages: German, French, English and Norwegian.

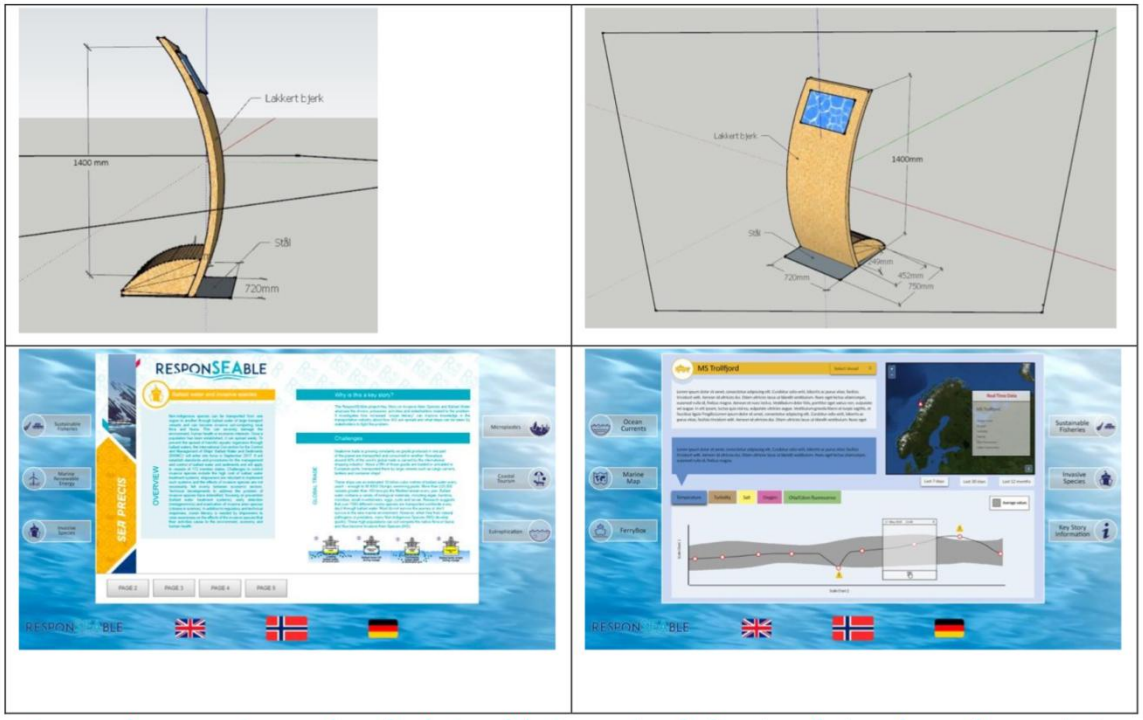

Figure 13-1. Sketch of the layout for the handmade birch wood platform with the integrated Interactive Platform. Screenshots taken during development and do not represent final version.

During the WP5 meeting in Berlin 5th and 6th of June 2017 as a piggyback to the Regional workshop of Eutrophication of the Baltic, the content of the Interactive Platform together with the other products was discussed and a list of contents and action points were set up. With these actions points and other feedback we got discussing the interactive platform we had a starting point for our story line meeting in Oslo 8th of August 2018 together with Grid-Arendal, shown in bullet points below (Seven Solutions could not join the meeting).

- Should be used in multiples places: ferries, museums, supermarkets.

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- Production of interactive communication tools. Should be able to host the serious game and visualisation task output
- Need sturdy touch screen specifically designed to be used in public areas
- Should be able to use data from Ferrybox; real-time on some ferries
- Could use more interactive use of data such as the New York Times "You Draw It" challenge (https://www.nytimes.com/interactive/2017/01/15/us/politics/you-draw-obama-legacy.html)
- Could start with a nice map as an entrance point to the portal
- Should be able to turn on and off layers
- Icons which lead you to the different stories
- Remember not to have empty spots
- Current location of the ferry could be based on a trajectory in the area, not the specific location (easier with regard to the unstable internet access)
- Children often more curious and interested, adults then follow
- Technical easier with a screen mounted on a wall than a platform placed on floor. This needs to be check specifically with the ferry companies.

During the story line meeting in Oslo, different concrete modules of the interactive platform was sketched, and more action points were defined (Figure 13-2).

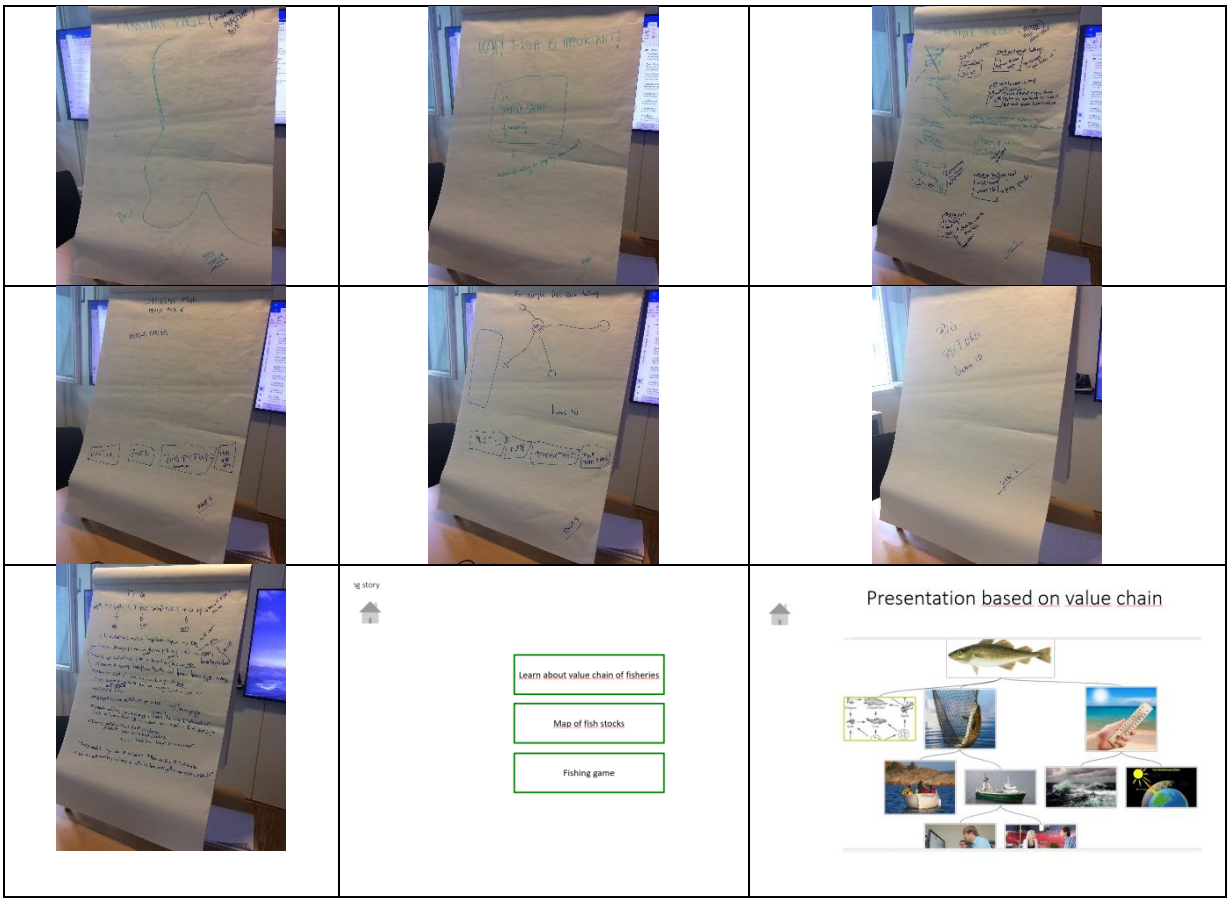

Figure 13-2: The sketches of the concept development in Oslo in august 2018

A concept of the Interactive platform was then developed (Figure 13-3). This concept was also presented at the ResponSEAble North Sea Regional Workshop arranged by NIVA in Oslo 12th September 2018.

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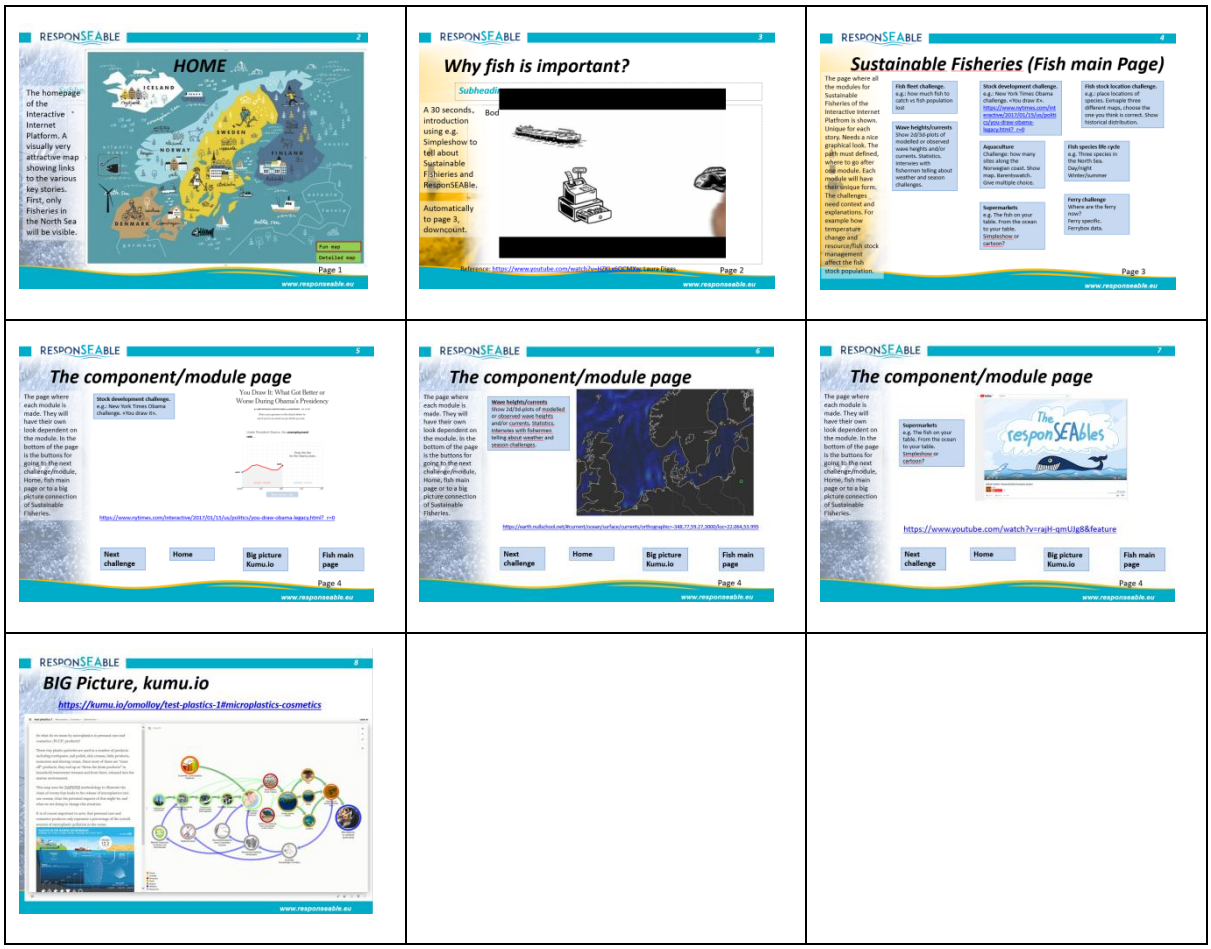

Figure 13-3: The concept of the Interactive Platform in august 2017

In a skype meeting together with Seven Solutions and NUIG the 19th of October 2017 it was decided to make a technical System Specification document that describes the different modules of the interactive platform and identifies the responsible partner for developing each of the modules. This was described in D5.7. Based on this technical layout the development of the interactive platform continued until the first deployment at the head office at NIVA (Figure 13-4).

During a couple of months of testing of the interactive platform at the NIVA head office together with further development, the interactive platform was ready for deployment on the vessels MS Trollfjord and MS Color Fantasy in April 2018.

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Figure 13-4. The landing page of the Interactive platform located at the NIVA head office in Oslo.

13.1 Ocean Literacy Objectives

Our target audience includes kids (6 years and older), and adults. Some of the content is perhaps more attractive to younger kids than adults such as the fish challenge (find the optimal combination of fishing vessels over time to manage a fish population sustainably). Other content, such as the details of the 6 ResponSEAble key stories are better suited at older kids or adults due to the detailed level and more serious content. The broad Ocean Literacy objective was for participants to develop a broader understanding of how important the marine resources are for people's everyday lives. The tools presented on the interactive platform under each Ocean Literacy topic (key story), approached Ocean Literacy dimensions of awareness and knowledge (on cause and effects of human activities on the ocean and solutions to reduce impacts). The Ocean Literacy tools ultimately aimed to inform attitudes and stimulate behaviour change with respect to taking actions to reduce or cope with human impacts on the ocean, and for people to understand the benefits from taking those actions.

Table 13-1 ResponSEAble tools included in the interactive platform

Key story in the interactive platform	**Tool presented on the interactive platform**
Microplastics in cosmetics	Cartoon film
Invasive species and ballast water	Cartoon film
Eutrophication	TVE short film (eutrophication in the Baltic)
Coastal Tourism	Systems interactive diagram, Cartoon film, *TVE short film*
Sustainable fishing and aquaculture	TVE short film (sustainable aquaculture), Fishing game
Marine Renewable Energy	Text and graphs on the energy provided by marine renewable energy technologies

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The interactive platform contained content from Ocean Literacy tools developed within all key stories within ResponSEAble (Table 13-1). Objectives within the Theory of Change logic models for those tools, presented in the relevant report on each tool, are relevant to the Ocean Literacy objectives approached by the interactive platform.

The inclusion of Ferrybox data and a live view of the ships track, as well as ocean current, sea surface temperature data and plankton species information provided participants with additional data to the tools contained in the key story menus. Ferrybox data was aimed to be intellectually fulfilling for all age groups and to be of interest because, as the cruise boat is travelling, new observations of the ocean realm are being collected. Informing the audience that these data are being used to manage our marine resources aimed to spur further interest as to why this kind of work is important.

13.2 Marine map application

One of several modules that have been developed for the interactive platform was a marine map application. Users can interactively project on the map interesting information related to the marine environment along the route of the ferryboat in the North Sea and the Norwegian Sea, including the following:

- ResponSEAble Stories. Short description on key stories of the ResponSEAble project such as the Tourism Story, the Fisheries Story and the Microplastics and Cosmetics Story. Users can be navigated to further information through appropriate links.
- Documented Coral Reefs in the Norwegian Sea
- Feeding and spawning areas of the North-east Arctic cod, the North Sea cod and the Norwegian spring-spawning herring
- The current sea surface temperature (near real time data)
- Current Chlorophyll a concentration in the sea (near real time data)

Except for the last two layers, all information is stored locally. All information is harvested from the following sources:

- The Norwegian Institute of Marine Research (www.imr.no)
- Satellite imagery: NASA's Earth Observatory
- The ResponSEAble Project (www.responseable.eu)

The application has been developed based on HTML5, CSS, Javascript, JQuery and OpenLayers. There were no special requirements regarding the responsiveness of the application as it was intended for use only on specific device.

Next to enhancing the map with additional layers, one could consider the following improvements to the Marine map application in future versions, which could not be implemented within the timeframe of the project:

- Project the route and the current location of the ferryboat on the map
- The legend for the sea surface temperature and chlorophyll is fixed to global values. The colors of the colorbar could be adjusted based on the actual viewport.
- Plot chlorophyll values in logarithmic scale to highlight the areas with peaks

13.3 Testing Undertaken

A larger survey focusing on change in participant's awareness, knowledge, attitude and indicators of behaviour change, following use of the interactive platform was completed on the Trollfjord ferry (Hurtigruten, Bodo – Kirkenes) and the Color Fantasy ferry (Color Line, Oslo-Kiel).

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13.3.1 Trollfjord ferry (Hurtigruten, Bodo – Kirkenes) 19th – 22nd November

Passengers on the ferry were mainly aged 50+ and from many nationalities. There were many British, German, Netherlands and Japanese passengers, as well as a smaller number of Australian and American passengers. Researchers from NIVA and the University of Plymouth provided a short presentation on the 19th of November during the 'daily gathering' where the expedition team provide lectures and information on the activities that will take place the following day. The presentation highlighted the interactive platform from the ResponSEAble project as well as the observational monitoring work NIVA continuously carries out on the ferries. After the presentation, passengers were encouraged to contribute to the project by visiting the 8th deck to find out more about the interactive platform and provide their feedback

Researchers from NIVA and University of Plymouth conducted surveys between 16:00 and 22:00 on the 19th, and between 8:30 and 22:00 on the 20th and 21st November (outside of meal times and meetings). Passengers who visited the platform were offered detailed information on the project and passengers were invited to complete a survey after using the platform. There was strong interest in the platform, although a lower interest in completing surveys due to meals and tour schedules. Many passengers suggested they were interested and would return later. Surveys were also left next to the platform to be available for completion when staff were not present. An invitation for passengers to complete the survey was attached to the platform.

Figure 13-5. Interactive screen on the 8th deck 'expedition team information area' of the Trollfjord ferry.

Passengers visited the expedition team counter (where the platform is located) on the 8th deck of the ferry, most frequently between 16:00 and 18:00 as this is where they also collect the schedule of activities for the next day. As the schedules were printed and made available near to the screen passengers often looked at the information on the screen at this time. Passengers also used the screens frequently in the mornings, between breakfast and leaving for activities and in the evening before or after dinner. Passengers came to the area infrequently throughout the day and evening to book activities with the expedition team. Between 11:00 and 16:00 was usually quiet as passengers were on activities/tours or at lunch.

There was a general interest in the screen and passengers noticed it easily as it was located within the area of the ferry that has information on tours, wildlife and activities (Figure 13-5). Level of interest in the screen depended on individual passengers. Many passengers were just interested in collecting the activities scheduled and only looked briefly at the screen. Other passengers investigated the screen and actively clicked on links, spending ~ 5 minutes looking at the information and materials and engaged with the NIVA and University of Plymouth researchers.

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Generally, passengers that were observed using the screen were all in older age groups (45+, mostly 65+). The expedition team staff and tour leaders permanently on the boats were also trained in the use of the platform and can provide information on the platform. Hopefully, they can continue to introduce passengers to the platform and explain the various tools installed.

20 participants completed the survey although not every feedback question (where the respondent has to provide information in text, rather than circle a scale response) was completed the results are summarised below.

13.3.2 Color Fantasy (Oslo-Kiel-Oslo), 23rd-26th November

The passengers on the Color Fantasy in November were of a mixed age group with the majority in the 35-55 years age range. The interactive screen was positioned in the same deck as the duty-free shop and main restaurant so at meal times and daytime when the shop was open there was regular foot traffic. However, due to the timing of the cruise we attended, before Christmas and during a weekend, a lot of the passengers were keen to shop, eat dinner and access bars. Although limited passengers spent time on the interactive platform on this trip, researchers from NIVA and University of Plymouth approached passengers to utilise the platform. A small proportion used the platform but, many declined to complete a survey. Still, the few people we got responses from were very positive about the platform.

In addition to completing surveys with passengers we also used a mobile tablet device to allow vessel crew (engineers, housekeeping and entertainment staff) to use the platform, which we followed up with a post survey. This approach had a much higher response rate. Some of these people were really engaged and were keen to explore the various products of ResponSEAble. As part of the surveys we provided a brief introduction of ourselves, the project and the products, and explained the informed consent practice. Using a portable platform (a small pc with touch screen and with the tool installed) connected to a wide screen in the machine room (engineering control room) or in the crew galley and lounge, the staff could decide two key stories they wanted to learn more about. Eventually, several of them saw all of the key stories and using the platform on their own. After the interaction, they filled in the survey on their own with guidance from NIVA and University of Plymouth staff if required.

13.4 Method used to evaluate effectiveness

13.4.1 Survey with users of the platform on board ferries

The effectiveness of the interactive platform has been measured using a questionnaire developed by Matthew Ashley from the University of Plymouth. The questionnaire used for the surveys conducted on the MS Trollfjord and on MS Color Fantasy is shown in section 13.9.

The survey instrument focused on assessing participant's awareness, knowledge and attitudes after using the interactive platform. The survey also assessed change between the self-reported frequency participants reported they currently undertook behaviours suggested for each key story, and the intended frequency after using the platform. Specific objectives within the dimensions of Ocean Literacy (predictors of behaviour change) for each stage within the Theory of Change logic model are summarised in Table 13-2.

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Table 13-2: Theory of Change model

	Problem Awareness /Knowledge	Knowledge	Attitude	Attitude – belief in benefit from own action (self-efficacy)	Interpersonal Communication / Social Norm	Behaviour Change
Theory of Change: AIM	Following the intervention participants will be aware (informed) of the issue or problem in the key story.	Following the intervention knowledge about the issue (key story) will have increased.	Following the intervention attitude towards the issue would have changed, and change in behaviour supported.	Following the intervention participants feel the response action will be effective (there will be a benefit).	Following the intervention participants will communicate about the issue or topic with friends, family and at work or school.	Behaviour adopted, or intention expressed:
Measurable objective	After using the interactive platform participant's Self –reported Awareness and Knowledge about how human activity effects the ocean will be >7, as will self-reported awareness and knowledge on how the ocean environment benefits people.	After using the interactive platform participant's Self –reported Awareness and Knowledge about how human activity effects the ocean will be >7, as will self-reported awareness and knowledge on how the ocean environment benefits people.	i) After using the platform, average participant's agreement to the statement: '*How concerned are you about the effects'* for the key story topic learnt most about on a scale 0 'not at all' (concerned) to 10 'very concerned, will be ≥7 (greater than moderate agreement).	i) After using the platform, average participant's responses to the statement: *'I believe there will be a benefit to the health of the ocean environment and human health if I take actions to reduce human impacts on the sea.'* (0-10 scale) will be ≥7. (greater than moderate agreement). ii) Participants will feel >moderately confident (>7) that they know what actions to take.	i) After using the platform, average participant's responses to the statement: *'I will sign petitions or join campaigns to reduce negative effects of human activity on the ocean.'* on a scale 0 'not at all' (undertake the action) to 10 'all the time', will be ≥7 (greater than moderate frequency). ii) If mean pre-course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.	After the course, mean response of participants will be ≥7 for at 1 of the intended behaviour options to '*help reduce the negative effects of human activity on the marine environment,'* ii) If mean pre-course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.
Indicator result (objective achieved (Y/N))	Post - survey responses **(Y)**	Post - survey responses **(Y)**	Post - survey responses **(Y)**	Post - survey responses **(Y)**	post- responses **(Y)**	post- survey responses **(Y)**

Throughout assessment of ResponSEAble tools, the objective has been for level of support for attitudes and behaviours to be greater than moderate (>7 on 0-10 scale). However, for the interactive platform, participants are in a busy atmosphere with limited time to concentrate on films and information for multiple tools. This is considered in interpretation of results.

The interactive platform covered all key stories. Survey respondents were asked to report which topic they had learnt the most about, in order to take this into account when interpreting results. The knowledge, attitude and behaviour questions were also designed to apply to multiple topics, either through being broad, or through containing multiple options, across all the different topics.

The theory of change objective, for respondent's agreement to be greater than 7 (moderate) on a 0-10 scale was expected to be challenging for this audience. The objective was originally applied to Ocean Literacy tools that were provided in a course or classroom setting that has less distractions than a public area on a ferry.

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Additional questions on participants pre-existing environmental connectedness and support for pro-environmental behaviours were added, to provide another factor as well as age, location and distance participant lived from the sea or coast, to assess influence on level of support for pro-environment attitudes and behaviours.

13.4.2 Usage statistics

In addition to surveys with passengers who have used the platform on board ferries, people's interaction with the platforms has been measured and stored in a database.

The number of visitors were counted automatically. When a new visitor enters the platform, each click into a new page is stored. The interactive platform has four content languages, and the database also records the use for each language. In addition to this, the fishing game has its own database developed by NUIG. All the data the fishing game gather such as age, gender and score are fed into this database.

All of these data are used to evaluate the effectiveness of the interactive platform, the usage while it is on board a ferry and the characteristics of the users and their interaction. We here only show statistics for the three platforms that are permanently installed on ferries and museums, excluding the platform in NIVAs offices as well as the mobile platforms used for non-permanent events (e.g., a mobile platform was used in the week-long Norwegian political event Arendalsuka, https://arendalsuka.no).

13.5 Methods- Description of the analysis performed on the data / surveys

13.5.1 Survey with participants on board ferries

The number of respondents within age categories and distance categories participants live from the sea were analysed and presented in charts. The topic participants felt they had learnt most about was also recorded and presented in frequency (number of respondents identifying each key story) charts.

Mean responses of the participants (on a scale of 0-10) in relation to questions associated with each objective in the Theory of Change model were calculated for survey responses (pre and post where available) (Table 13-2). To test significance of changes between pre and post survey responses, paired samples t-tests were calculated and significance defined with Bonferroni correction such that only comparisons with $p < 0.005$ are interpreted as significant.

As participants were from very different age categories and locations between each ship surveys were carried out on, results from surveys were analysed separately for data from each ship, as well as in combination, for all responses across all ships.

13.5.2 Usage statistics

The interactive platforms log the number of the views of each page per day and per language. They also log the outcome of the game in the game module, including the points and the information entered by the user at the end of the game (age group and gender). When calculating the number of visitors, it was assumed that on average, two visitors used the console at a time. The session timed out after 35 seconds if there was no activity; new activity is then counted as a new group of visitors. Note that due to an error, the two first age groups were labelled «2-11» and «6-15» on the consoles. In the statistics, we have denoted these groups «2-8» and «9-15».

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Data gathered from the visitors on all platforms.

The use of the interactive platforms increased sharply when the Norwegian summer holiday started in the start of July. There was on average 429 visitors per day in July and 356 visitors per day in August. In the months September to December there was on average 228-240 visitors per day (Figure 13-6, top). Each visitor viewed 2.3 – 2.7 pages on average, with the highest number of pages viewed (2.7 pages) during July (Figure 13-6, bottom). The platforms were used quite evenly during the week, which reflects that they were mainly used by people on holiday (Figure 13-7).

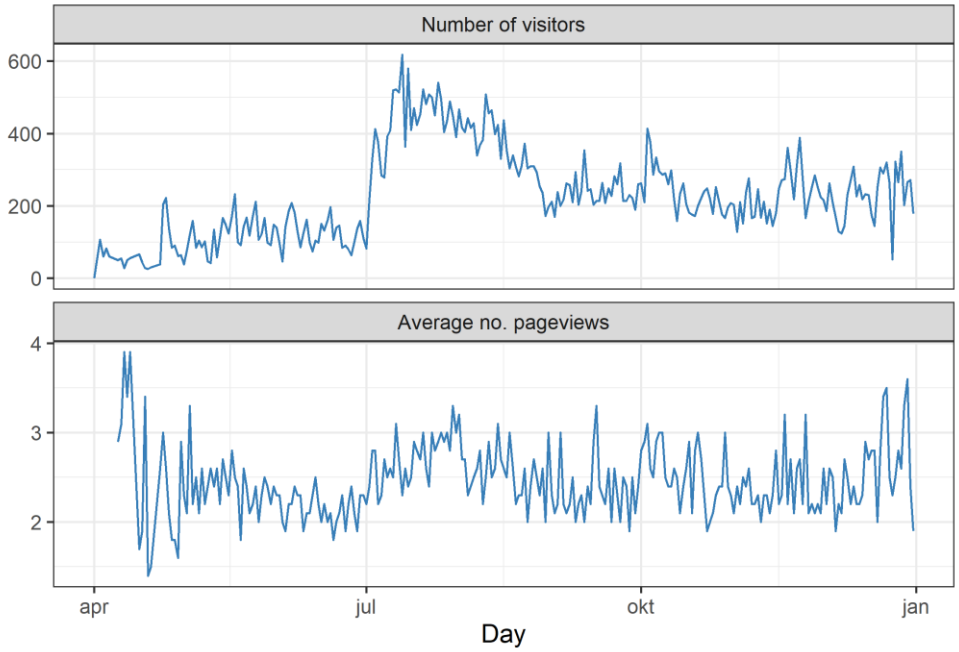

Figure 13-6. Daily number of visitors and average number of page views per visitor during 2018.

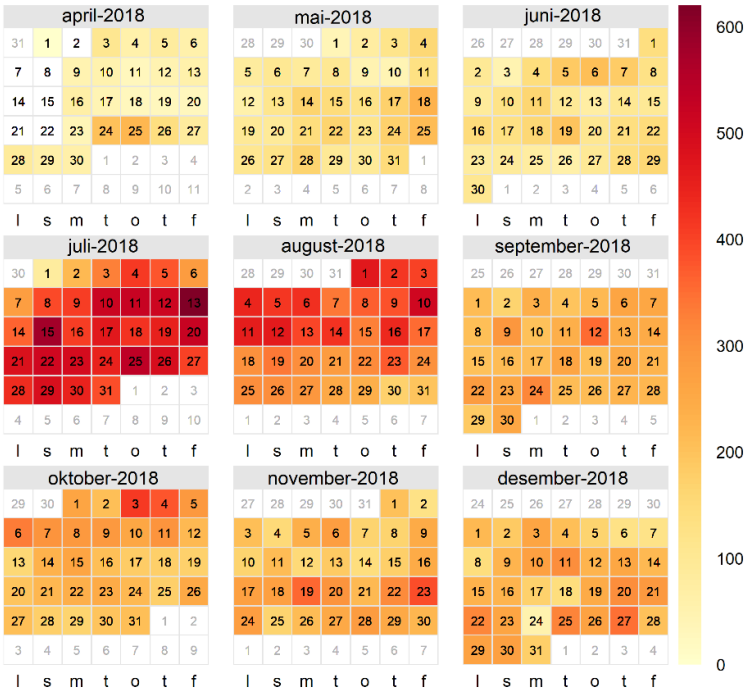

Figure 13-7. The daily numbers of visitors visualized on a calendar.

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There were in total 82626 visitors to the three platforms. The two most popular languages were German (34304 visitors, 41.5%) and Norwegian (26480 visitors, 32%), with English a bit behind; very few chose French (Table 13-3). The two most popular pages were the “Marine map” (24% of views) and “Currents” (20.2%), followed by the “Ferrybox” (16.8%) and “Invasive species” (15.5%) (Figure 13-8). There was some relationship with language, with for example German-speakers being more interested in the maps (31.5% of German page views). The “Key stories” and “Fisheries” had fewer views (11-12%), and very few people (0.9%) went to the “Plankton” page. From the “Key stories” page, more people went on to the “Coastal tourism” (22.7%) and “Microplastics” (19.7%), with least people going to Eutrophication (14%) and Marine Energy (13%) (Figure 13-9). The ranking of the different key stories was quite similar among languages (Figure 13-11), but the English had the biggest differences in interest.

Table 13-3: Total number of visitors by language

Language	Visitors	Visitors (%)
English	17314	21.0
French	4528	5.48
German	34304	41.5
Norwegian	26480	32.0
Total	82626	100.0

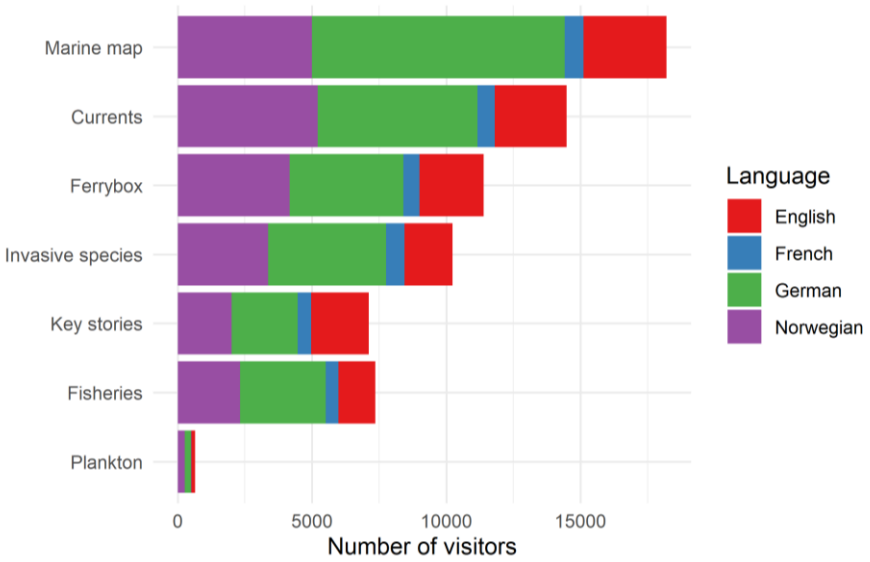

Figure 13-8: Pages chosen from front page

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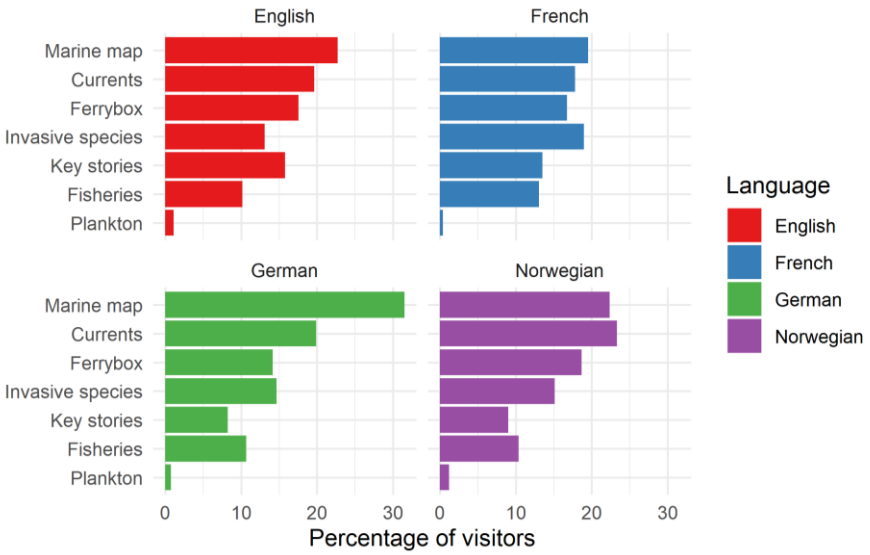

Figure 13-9: Pages chosen from front page by language

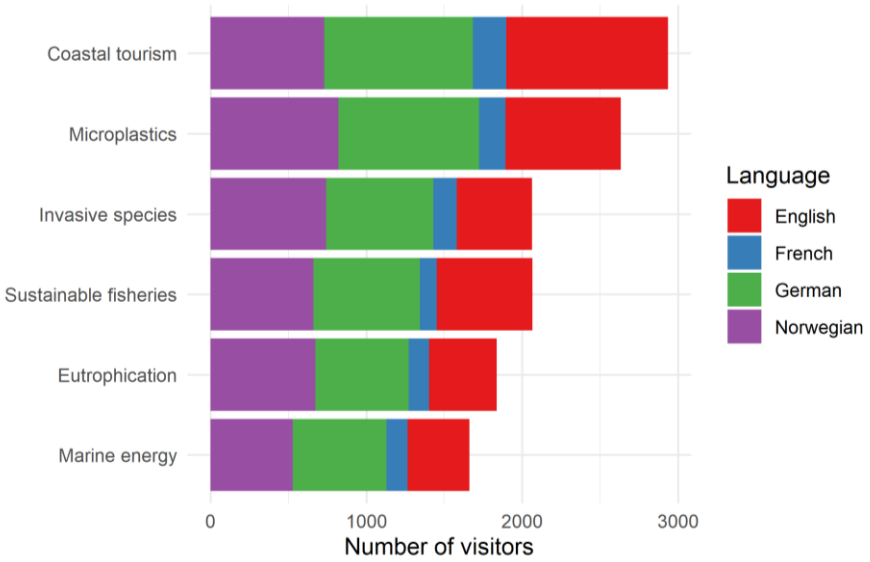

Figure 13-10: Pages chosen from Key Stories page

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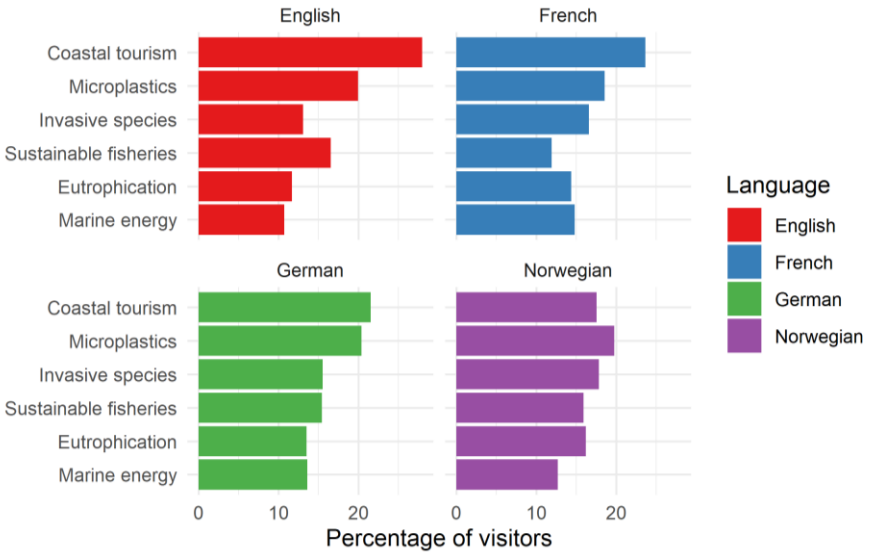

Figure 13-11: Pages chosen from Key Stories page by language

The fishing game attracted most interest among older children and young teens (Figure 13-12). It was more used by males than by females; this difference was particularly big for adults between 22 and 60. Few adults used the game in the coastal steamer Trollfjord and in Runde Environmental Centre (Figure 13-13). The youngest children often achieved a very low number of points, indicating that they didn't get the point of the game (or didn't really try) (Figure 13-14). The number of points was higher for the older children and teenagers, and reached a peak in the age group 22-40, where 24% achieved the maximum number of points (Figure 13-15).

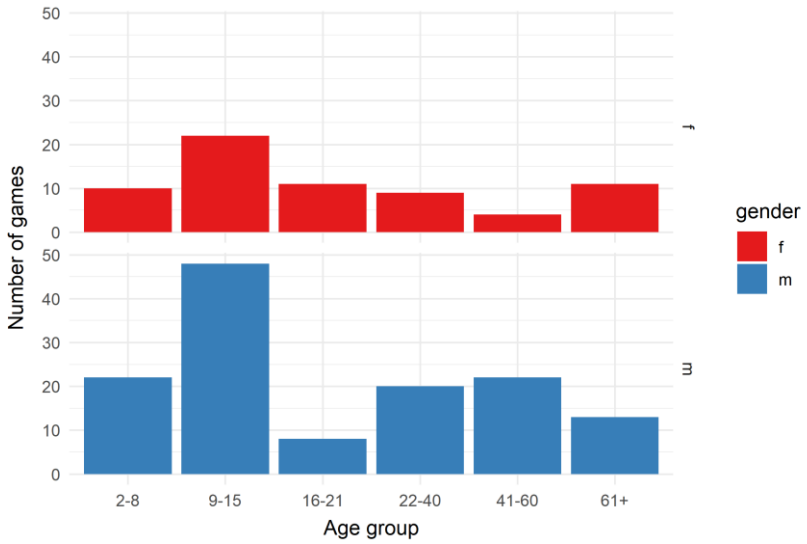

Figure 13-12: Number of games by age group and gender

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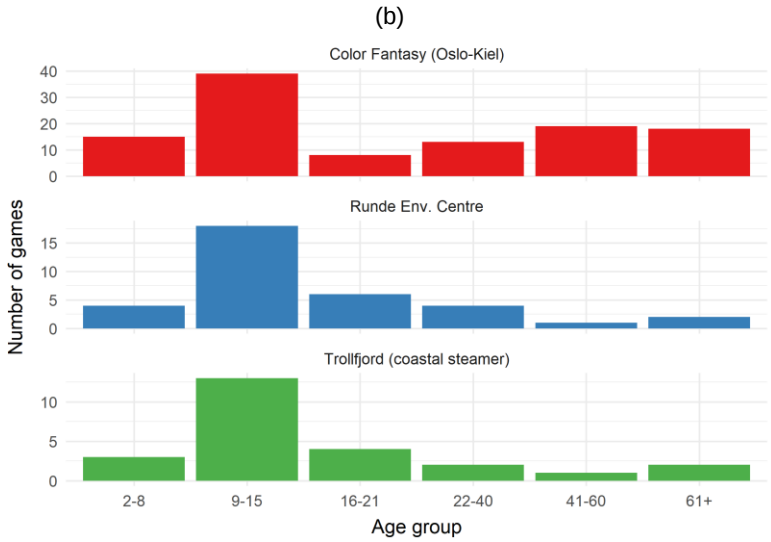

Figure 13-13. Number of games played divided by age as well as (a) gender and (b) location (only for the three permanent consoles).

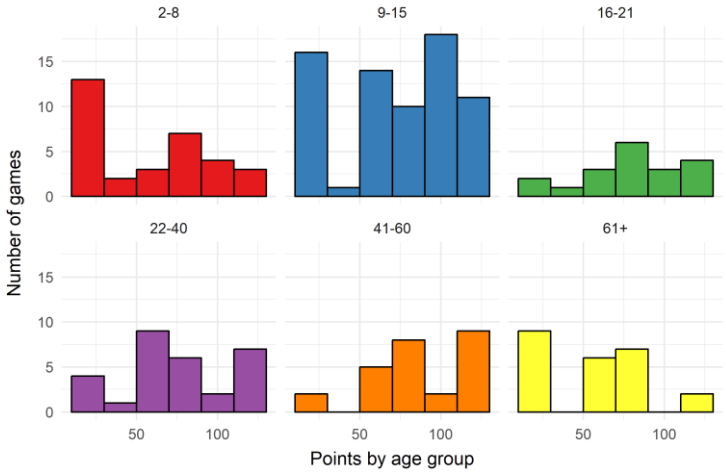

Figure 13-14: Points by age group

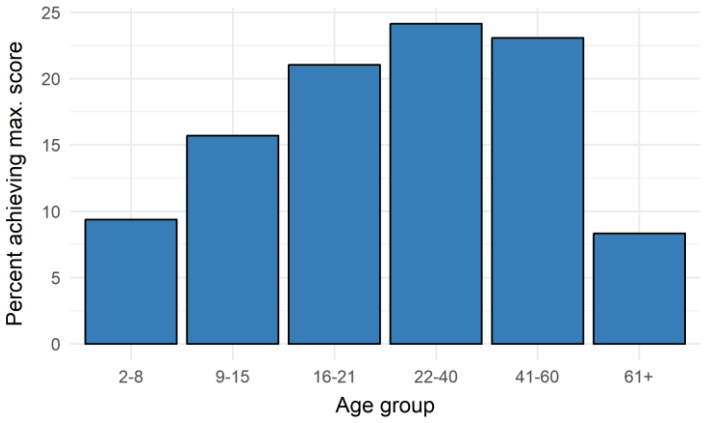

Figure 13-15. The percent of players achieving maximum score.

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13.6 Survey Results

13.6.1 Demographics and distance participants live from the sea

A total of 39 participants completed surveys after using the interactive platform and viewing the Ocean Literacy tools developed by ResponSEAble. Nineteen surveys were completed on board the Hurtigruten vessel 'Trollfjord', participants were mainly in older age categories (55-64 and 65+). Twenty surveys were completed on board the Color Line vessel 'Color Fantasy'. Participants on board the Color Line vessel were in younger age categories, all below retirement age, which is understandable as 17 respondents were working within the crew (engineering or hospitality professions on board the ferry) (Figure 13-16).

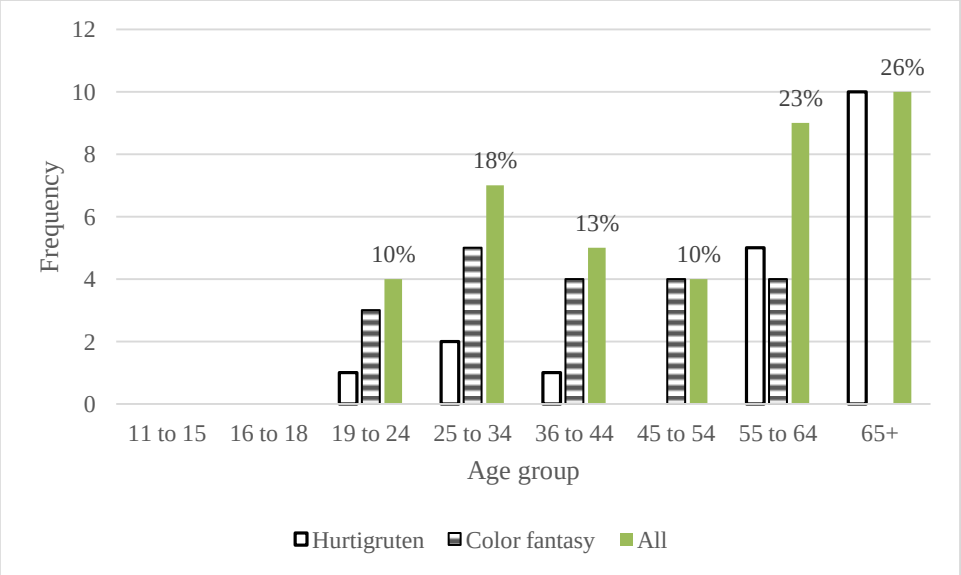

Figure 13-16 Age category distribution of respondents

Across all respondents from all ships, 74% were male and 26% female. There was a much more even sample of genders from the Hurtigruten surveys, with 56% of respondents male and 54% female. Respondents on the Color Line vessel were 91% male and 9% female.

A moderate percentage of participants of surveys on both vessels (45-47%) lived very close to the coast (0-5 kilometers). A much greater proportion of respondents on the Color Line vessel (35%) lived >50 kilometers from the coast than the Hurtigruten vessel (5%), influencing the overall statistics (Figure 13-17).

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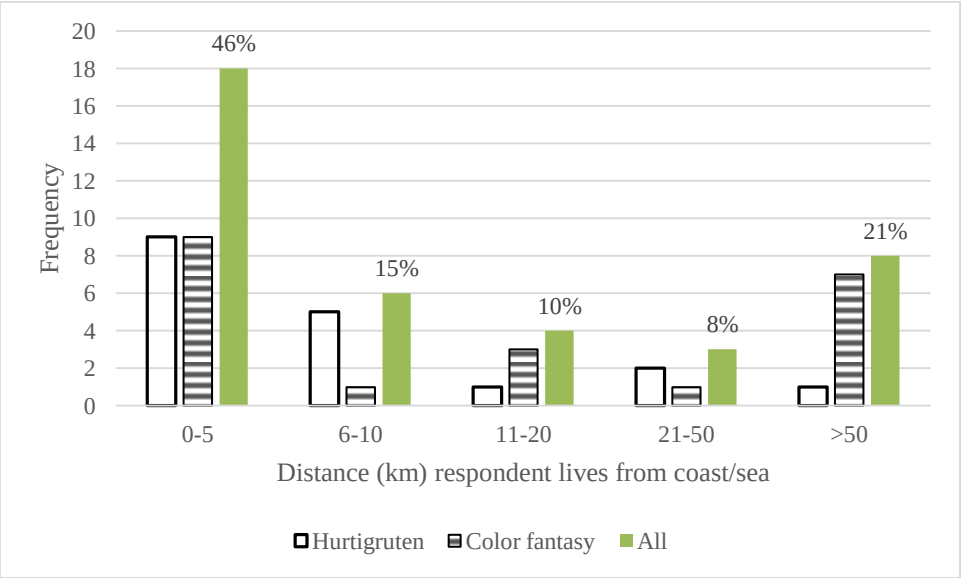

Figure 13-17 Frequency of respondents living in each distance category from the coast

13.6.2 Theory of change objectives

The microplastics in cosmetics key story topic was reported by most participants as being the topic most learnt about on both ships (49% of all respondents) (Figure 13-18). A small % of respondents (18% across both ships) reported they learnt the most about the 'invasive species in ballast water' topic (Figure 13-18). Smaller % of respondents reported coastal tourism and eutrophication topics as being the ones they learnt the most about (12% across both ships, for both topics) (Figure 13-18). Interestingly the 'top 3' the participants reported they learnt the most about, were also the top 3 topics that were first clicked on in the usage data (collected over a longer time period than the surveys were undertaken).

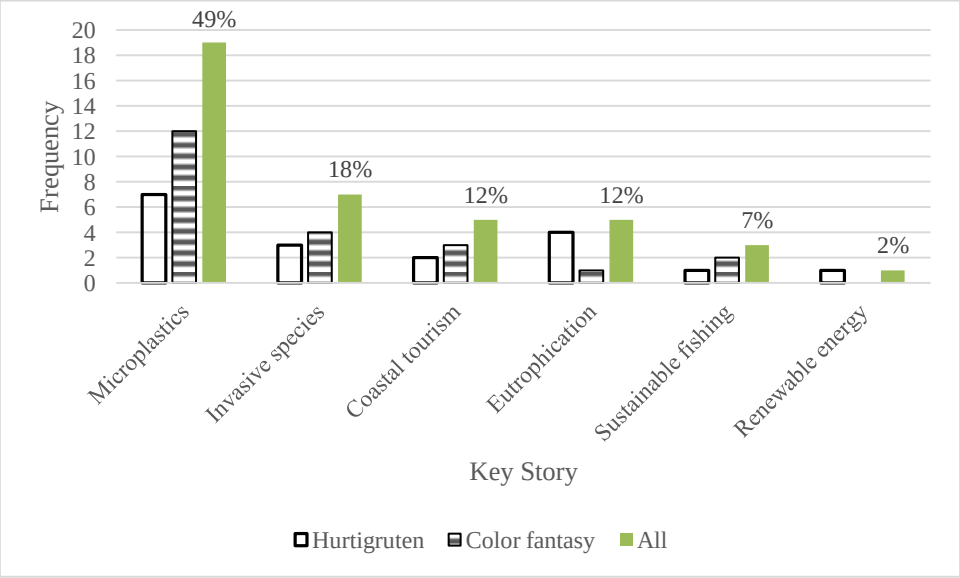

Figure 13-18 Number of respondents identifying each key story category as the one they learnt the most about

Theory of Change objectives were not met for awareness and knowledge objectives, other than for respondents aboard the Hurtigruten vessel (for Color Fantasy vessel respondents self-reported level of knowledge was moderate (5-6 on 0-10 scale) for both how humans impact the ocean and the benefits people receive from the ocean) (Table 13-4, Figure 13-19).

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All Theory of Change objectives were met for indicator questions relating to Attitude Ocean Literacy dimension (Table 13-4). One of the two Behaviour Change Ocean Literacy dimension indicators was met, as although average intended frequency of undertaking each behaviour across all participants was below 7 for all options but '*choose sustainably sourced seafood',* there was a significant increase in support for the all actions (Table 13-4, Figure 13-20). There was a difference between intended frequency of behaviours for all options, between respondents from each ship (Table 13-4, Figure 13-20). Respondents on board the Hurtigruten vessels displayed high (>7) support for undertaking behaviour options, related to the topics they had learnt most about (Figure 13-20). Respondents on board the Color Fantasy vessel, showed a significant increase in intended frequency of undertaking actions compared to current frequency, after interaction with the tool, but intended frequency was still only moderate (below 7) (Figure 13-20).

There was a significant increase in the frequency respondents intended to sign petitions or join campaigns to support actions to reduce negative impacts of human activity on the ocean' an indicator of the Ocean Literacy dimension 'communication/social norm' (Figure 13-20). Although the respondents on board the Hurtigruten vessel reported a higher frequency of '*talking about helping to reduce the problems in the ocean environment caused by human activity'* (average 6), both sample groups reported moderate levels of this indicator of communication/social norm (Figure 13-19).

Table 13-4 Results for indicators for objectives within each stage of the Theory of Change Logic model

	Problem Awareness /Knowledge	**Knowledge**	**Attitude**	**Attitude – belief in benefit from own action (self-efficacy)**	**Interpersonal Communication / Social Norm**	**Behaviour Change**
Measurable objective	After using the interactive platform participant's Self –reported Awareness and Knowledge about how human activity effects the ocean will be >7, as will self-reported awareness and knowledge on how the ocean environment benefits people.	After using the interactive platform participant's Self –reported Awareness and Knowledge about how human activity effects the ocean will be >7, as will self-reported awareness and knowledge on how the ocean environment benefits people.	i) After using the platform, average participant's agreement to the statement: '*How concerned are you about the effects'* for the key story topic learnt most about on a scale 0 'not at all' (concerned) to 10 'very concerned, will be ≥7 (greater than moderate agreement).	i) After using the platform, average participant's responses to the statement: *'I believe there will be a benefit to the health of the ocean environment and human health if I take actions to reduce human impacts on the sea.'* (0-10 scale) will be ≥7. (greater than moderate agreement). ii) Participants will feel >moderately confident (>7) that they know what actions to take.	i) After using the platform, average participant's responses to the statement: *'I will sign petitions or join campaigns to reduce negative effects of human activity on the ocean.'* on a scale 0 'not at all' (undertake the action) to 10 'all the time', will be ≥7 (greater than moderate frequency). ii) If mean pre-course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.	After the course, mean response of participants will be ≥7 for at 1 of the intended behaviour options to '*help reduce the negative effects of human activity on the marine environment,'* ii) If mean pre-course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.
Indicator result (objective achieved (Y/N))	Post - survey responses **(N) - only Y on Hurtigruten vessel**	Post - survey responses **(N) - only Y on Hurtigruten vessel**	Post - survey responses **(Y) - for the top 3 topics that participants reported they learnt most about**	Post - survey responses **(Y)**	post- responses *I) (N) but ii)* **(Y) - a significant increase between current and intended frequency**	post- survey responses *I) (N) but ii)* **(Y) - a significant increase between current and intended frequency**

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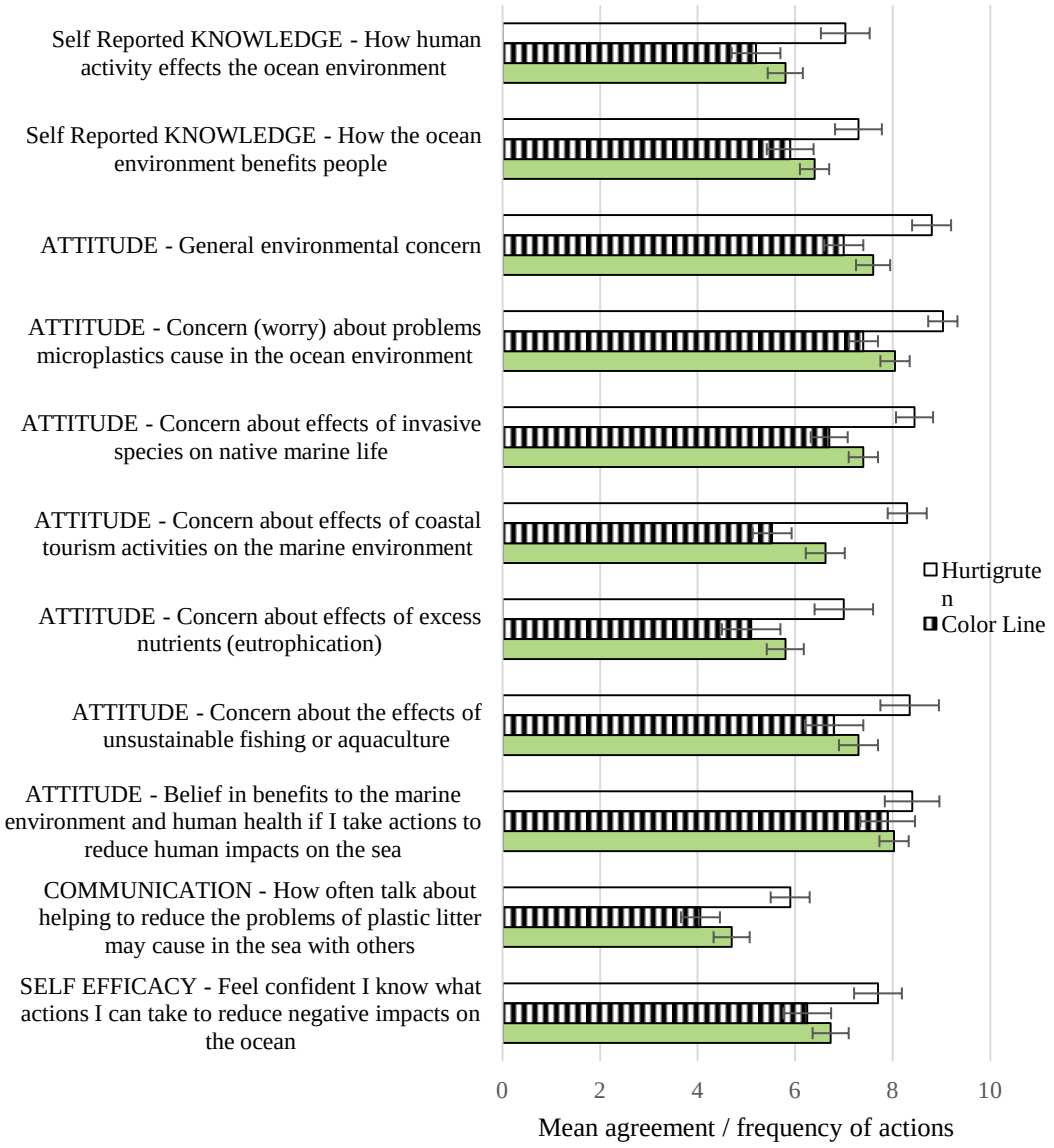

Figure 13-19 Knowledge, attitude, communication and self-efficacy indicator question results for responses from the Hurtigruten vessel, Color Line vessel surveys and combined results.

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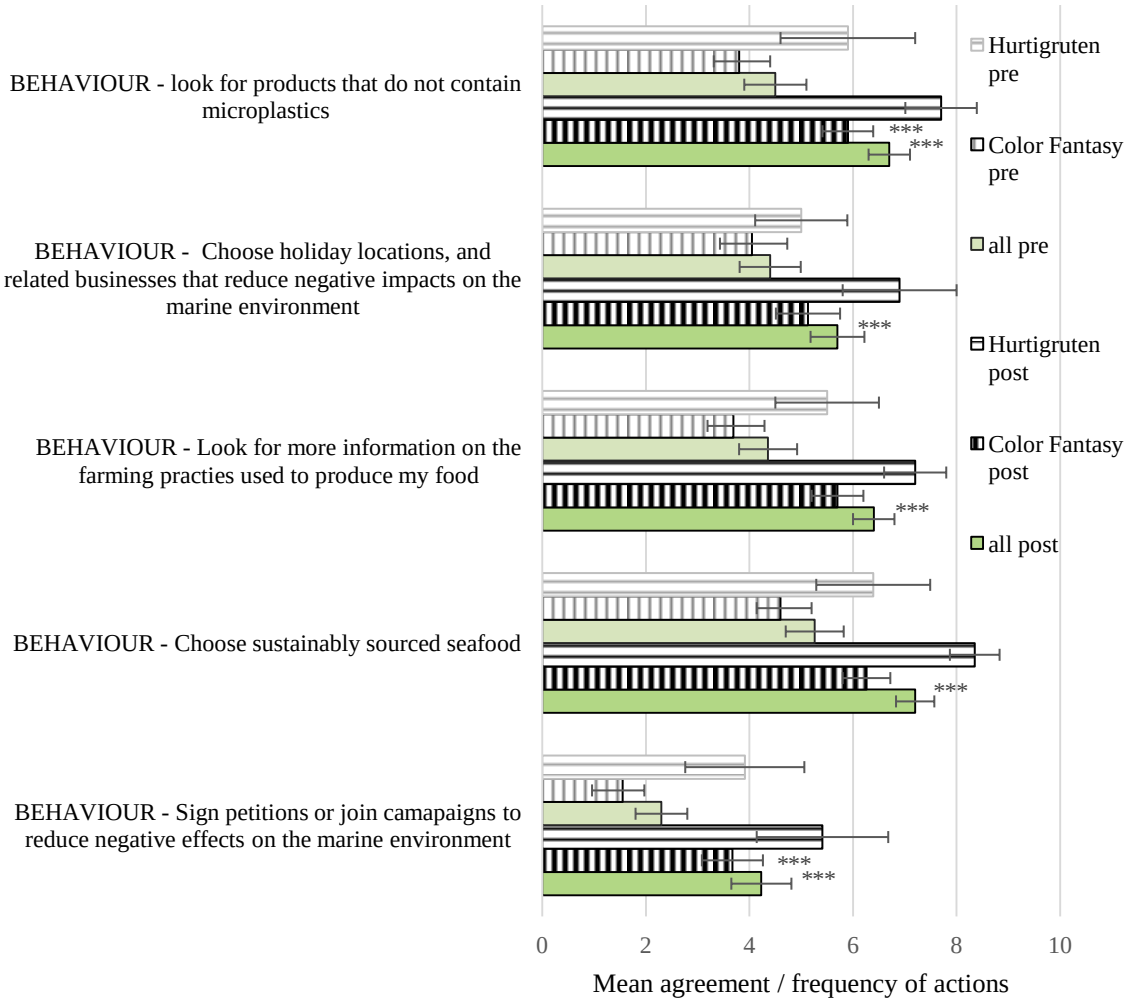

Figure 13-20 Current and intended self-reported Behaviour indicator question results for responses from the Hurtigruten vessel surveys, Color Line vessel surveys and combined results.

13.6.3 Ocean connectedness results.

In addition to questions about concern for human impacts on the environment there were three questions adapted from environmental and emotional connectedness questions. Across all surveys there was low agreement with the statement, *'I often feel disconnected from the ocean environment'* (average 3.3 SE± 0.4). Disagreement was greater from average responses from respondents on the Color Line vessel, although variation in responses was greater for respondents on the Hurtigruten vessel (Color Line, average 3 SE± 0.4, Hurtigruten average 4 SE± 0.4). Responses to other ocean environmental connectedness questions showed greater connectedness (or emotional responses) from respondents on the Hurtigruten vessel, although average responses across all vessels showed high connectedness (Table 13-5).

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Table 13-5 Average response and variation (SE) in relation to ocean environmental connectedness questions

	All responses	Hurtigruten	Color Line
'I often feel disconnected from the ocean environment'	3.3 SE± 0.4	4 SE± 0.4	3 SE SE± 0.4
'I always think about how my actions will affect the ocean environment'	6.03 SE± 0.5	7.1 SE± 0.7	5.5 SE± 0.6
'It makes me sad to hear about damage to the natural environment'	7.9 SE± 0.3	9.2 SE± 0.3	7.2 SE± 0.4

13.6.4 Responsibility

Across all samples, respondents identified Government action ('*Governments support approaches that ban or reduce actions that have negative effects on the ocean environment*') to be the most effective option to reduce the impact of human activities on the ocean environment (average agreement 8.0 SE± 0.3). Next highest agreement was for the option, '*Businesses and industries reduce their negative impacts on the ocean environment'* (average 7.7 SE± 0.4). There was lower (moderate to high) agreement that the most effective option to reduce the impacts of human activities on the ocean environment was for individuals (*myself and others*) to, *'only buy products and take actions that reduce impacts on the ocean environment'* (average 6.6 SE± 0.3).

13.6.5 Discussion – main findings and what they represent

All theory of change objectives were met for passengers on the Hurtigruten vessel. It is important to consider that the respondents average pre-existing emotional dimensions of connection to ocean issues and initial concern for the ocean were higher for the Hurtigurten sample than the Ocean Line survey. Pre-existing ocean connectedness of respondents on Color Line vessel was highest, which may be influenced by 85% of respondents working in crew roles aboard the vessel (Color Fantasy) when surveyed. The Hurtigruten passengers were passengers on a ferry/cruise that focused on educational expeditions about the natural and cultural environment, which reflects the slightly higher level of emotional connectedness identified in the survey responses.

Theory of Change objectives were met for attitude dimensions from survey respondents on board the Color Line vessel, including belief in benefits from undertaking actions and concern (for effects of general human impacts and also the key story topics of microplastics in cosmetics and sustainable fishing and aquaculture). The second of the two intended behaviour objectives were met for the Color Line respondents. There were significant increases between self-reported current frequency of undertaking behaviour and intended frequency of undertaking actions, for microplastics and also for the action of signing petitions or campaigns (also recognized as a social norm/communication objective). Although the lower intended frequency of undertaking actions reported by Color Line vessel respondents lowers the average frequency of undertaking intended behaviours, across all surveys, the second behaviour objective is still met for the 'all' sample.

Despite the objective of intended frequency of undertaking behaviours not being met in results from Color line respondents, the large increases, between current frequency and intended frequency (highly significant for two relationships), suggest the information on the platform has had a positive impact. As there was a significant increase in response of intended frequency to sign petitions and join campaigns, suggests there is great potential for multiplying the messages.

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In future studies, recording objective data on participant's frequency of undertaking these actions would be of great benefit to transferring inferred behaviour intentions to actual recorded behaviour following interaction with the platform.

User statistics recorded 82,626 visitors to the platform over 9 months, across multiple nationalities. Survey responses from each vessel and the combined results, displayed an increase in knowledge, attitude, communication/social norm and intended behaviour indicators, following interaction with the platform (and the ResponSEAble tools contained in it). Although stricter Theory of Change objectives, designed for individual tools were not met for self-reported knowledge objectives, objectives for attitude dimensions were met. At least one of two objectives within communication and intended behaviour objectives were also met across all surveys. Given the very large number of users recorded by the user statistics, the opportunity the platform provides and the positive effect on survey respondents Ocean Literacy dimensions (and even intended behaviour), suggest the platform is an effective means of sharing information and key messages.

The Theory of Change objectives associated with ResponSEAble Ocean Literacy tools within the platform were set for groups that would be spending dedicated time to watching the material, as part of education events. It is recognized that in a busy public environment on a ferry there are many distractions and concentrating on the material is more difficult for participants. The increase in knowledge of the actions to take, attitude of concern and belief in benefits, a recognition that action is necessary and increase in intention to undertake actions are all key predictors of behaviour change (Klockner, 2013; Pahl & Wyles, 2017). As these indicators display an increase in surveys, the platform provides a means of sharing snap shots of information about the issue and promoting behaviour change. The information provided, however, is only as good as the tools within the platform.

The topics receiving the most interest, those that relate to either the greatest levels of concern related to effects (microplastics, invasive species, sustainable fishing and aquaculture) or greatest intended frequency of undertaking behaviours (microplastics, sustainable fishing and aquaculture and eutrophication) all had cartoon film, short documentary films, or interactive material representing them. Messages within the cartoons and videos appear to have been understood and the tools therefore provide a good means of sharing information on the platform. The Marine Renewable Energy topic contained only one page with simple graphs and limited text and this may relate to the topic being reported as the one that participants learnt the least about. However, it is recognized there is limited feedback on the tools themselves within the surveys.

Comments for participant's on '*what they remember most from the ResponSEAble information you have seen?',* highlighted the ocean current, temperature and plankton species information provided by NIVA was of interest. Microplastics and the need to buy less cosmetics containing them and the need to treat ballast water and effects of invasive species were the only two key story topics mentioned in response to this question. All these topics were represented by cartoons or interactive material. Although some of the older aged respondents suggested the cartoons were better shown to school aged children, the messages appear to have been remembered by a large proportion of respondents.

13.7 Lessons Learned

The making of an interactive platform needs a lot preparation, not only for the content but also for the main design and set up and the functionality of the interactive platform. For this project the timescale was too tight to develop the "infrastructure" and the design from scratch, and we needed to build on an infrastructure already available. In addition, finding the right kind of format and approach for designing and implementing an interactive platform is difficult as it depends on the type of information to show and how it will be presented to the audience. All these criteria and concerns are again dependent on the competence of the developers or on the ones responsible for developing the interactive platform. From NIVAs' perspective we developed the interactive platform in collaboration with our partners and with

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contractors providing detailed information on the hardware and implementation mechanisms for the platform engine. For 6 months we had weekly meetings over video where we discussed the design, content implementation, concerns, problems, responsibilities, and successes. In the end this approach where all participants in the project could discuss with each other each week proved to be very efficient for development and kept everyone up to speed as to how and where development was moving. After the beta testing and deployment of the platform on two cruise boats, we decided to develop the phytoplankton module as that kind of content was missing from the overall marine ecosystem understanding of the platform. We also saw it would be very nice to visualize what kind of marine organisms inhabit the cruise passengers at any location and show how these organisms change with seasons. Overall, the development of the platform was successful, but depended on the fact that we could build on top of an existing engine where our platform content could be visualized; starting from scratch would require another year of development.

Doing the Living Lab concept during this development was difficult because a lot of effort was put on having the momentum and progress to makes sure the interactive platform would be ready for the deliverable time (March 2018). Our experience was that it would take too much time for a user group to give feedback on a tool under development with no hands-on tool to test. And it would take too much to change the design if the user group had to wait for a test version and then give feedback to this version which would need to change again. This process would probably take much longer time, probably years, and the development should have started straight from the start of the project and not wait on other work packages. Therefore, the Living Lab testing was not used under the development of the interactive platform other than during internally testing at NIVA head office.

The survey performed on the vessels worked very well even though we did have fewer interviews than expected at Color Fantasy. The feedback was very good and that this was something we should continue doing. We did not get any detailed feedback on the design of each of the individual modules.

13.7.1 On board Trollfjord and Color Fantasy

The settings for our outreach on board the cruise ship MS Trollfjord are the interactive touch screen, centrally located on board where information about tours and the cruise itself and the expedition team are located. The audience on board is international and typically >60 years old and have an interest in learning (or already know quite much/have opinions) about the sea. The interactive screen works well and attracts people to investigate the material. However, for the audience on board, texts may have worked better than movies. The map seemed to easily attract people. The Ferrybox data from Trollfjord that is shown on the monitor was very good to use to show and explain the screen, since it contains and shows data that people easily can relate to such as water temperatures. From there on, we could use their new interest to show e.g. different algae species in that module or show them the links to the ResponSEAble movies on plastics, sustainable fisheries etc. and let the audience explore the information screen on their own.

In Color Fantasy the interactive platform is centrally located outside the tax-free shop entrance. The audience is international, but also with a lot of Norwegians. Some passengers are younger keen to shop, eat dinner and access bars, others are there with their family including kids. During the first day of our interviews, people seemed a bit annoyed of us being there. Several of them said they would come back later to try it so we could interview them, but they didn't. The timing was probably not the best, with the start of a weekend before Christmas. It would probably be better to do the interview during summer or a school holiday where more family would join the cruise. Due to the lack of interest being interviewed from the passengers, we got the chance to interview staff members on board Color Fantasy. Some of these people were really engaged with a much higher response rate.

When we as scientists wanted to capture people's attention on board a cruise, the following concept worked well. Provide a short presentation about ourselves during one of the expedition team's daily information meetings with the passengers. As with all outreach, the key here is to keep the presentation clear, short and deliver an easy message, e.g. "We use Trollfjord as a research platform where our Ferrybox continuously collects ocean data on temperature and particles in the water that we can use to monitor the state of the sea. The interactive platform highlights these data in

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real-time and we have also added several movies and information on e.g. microplastics, ballast water treatment and invasive species. Feel free to come and talk to us".

While standing around the screen, the map and Ferrybox is a good start to get people interested. Sea temperatures is something everyone can relate to, and hence, that is a good beginning before moving into particles, algae data or the movies on the screen.

13.8 Guidance for future development of OL tools

Defining the Ocean Literacy objectives and the identification of the target audience is quite related and interlinked but defines the "competence" level of the content. The age group should be defined, or it should be decided if it should be content for various age groups.

With an early design process with user groups, the type of content could be discussed. This would maybe help on how the interactive platform could be designed e.g. kind of modules and what kind programming language. Still, it could be a difference between what the user group would like and what is possible to develop.

Developing an interactive platform could/should start after the design process, but writing the technical specification document is fundamentally important in order of providing a concrete action plan for the developers.

As part of the development process it is critical to test the platform with selected users and different user groups.

An interactive platform development should be based on existing infrastructure solutions that provide a much faster start-up and development time. Don't waste time developing something that already exists and which has been tested. Instead, spend time developing the content of the platform.

Use versioning tools for developing software to make sure that you can pin-point when and where software problems occurred to get rid of bugs.

Using both surveys and data from the user interactions is a good measure of the interactive platform. The behavioural change is most likely difficult to measure without using the survey measure.

This kind of development is a very time-consuming process and would have needed a much longer development period than was spent in the development of this interactive platform.

13.8.1 Future development

For the future on board Trollfjord, if we can get the expedition team to use the platform even more actively with the tourists (they do mention it to the tourists and are aware of it), we will probably encourage more people to use it. For Trollfjord specifically, the audience is interested in the environment, they are very international, and in general at an age near or already retired. For this audience, short, informative texts would probably work better than movies, although the movies did receive positive feedback as well. The presentation of the Ferrybox could be improved by highlighting several variables simultaneously to show how various factors interact (e.g. by seeing temperature and chlorophyll a at the same time). These graphs could be made more explanatory to the audience by adding more descriptive information e.g. explaining why the temperature goes up and down within a few days (local effects).

13.8.2 Design of Test (of Effectiveness) instruments (e.g. surveys)

During the interviews of the passengers on board both Trollfjord and Color Fantasy, the surveys were experienced quite long. The people we interviewed got after a while a bit inpatient and we felt the need to speed up to finalize. With fewer questions, maybe even more discussions or feedback would be given because of less time used on asking new questions. Therefore the survey should probably have been shortened.

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13.8.3 Summary of passenger interaction with the platforms observed on ferries

Trollfjord ferry (Hurtigruten, Bodo – Kirkenes) 19th – 22nd November

Overall, the cartoons on microplastics and invasive species generated the most interest and the take-home messages were remembered well. Survey respondents, who had looked at the detailed video and text information on eutrophication and coastal tourism provided feedback that they had learnt a lot on these topics. Although fewer people spent time reading the detailed coastal tourism information, those that did responded that they had learnt the most about this topic. Although one respondent suggested the microplastic cartoon was aimed at 4-year olds and poor for adults, a much higher number of respondents felt they had learnt about this topic. Due to the limited time passengers spent investigating the information and the distraction of other events (meals, tours, expeditions) on the ferry trip, the cartoons on microplastics and invasive species appeared to provide an accessible means of sharing the message of the key stories. Respondents who had a lot of background information on the key stories already (retired teachers and expedition staff) were most interested in the Ferrybox information and felt they learnt the most from the interactive sea surface temperature and ocean currents graphics.

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13.9 Survey Forms used

RESPONSEABLE

(Please complete the details below)

Location (town or city):

_____

Date and Survey identification *(date and individual number – please add todays date and an ID number, e.g. using your parents initials and a memorable house or flat number (e.g.MAWA3). Surveys and data are anonymous, the survey ID you provide will allow you to identify your data if you want it withdrawn at a later date).*

_____

Please read the following:
This survey forms part of a study being carried out to evaluate the effectiveness of ocean literacy (awareness raising and training) materials developed under the ResponSEAble project. This work is funded by EU Horizon 2020.

The survey should last no longer than 10 minutes. Answers given will **remain confidential** and only anonymised and grouped data will be used in the analysis and reporting. By taking part in this survey you are consenting to your data being used as part of this study. You have the right to withdraw from this survey or to request your data are removed from the project up until December 2018 by emailing your request and the **survey date and survey identification** of your questionnaire to: matthew.ashley@plymouth.ac.uk. You do not have to answer any individual question if you do not wish to do so.

By ticking the following box, you indicate that you have read and understand the information provided above, that you willingly agree to participate and that you may withdraw your consent before December 2018 and discontinue participation if you wish.

☐

If you have any concerns about the survey or the use of your data in scientific publications you can also contact University of Plymouth's research ethics committee, by contacting Paula Simson, paula.simson@plymouth.ac.uk.

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1. In the interactive platform there were many ocean and environment topics, what did you learn the most about?

Please list the top 3 options you learnt the most about (from 1 = highest, 3 = 3rd highest)

Microplastics		Other topic:	
Coastal Tourism			
Eutrophication and Agriculture			
Sustainable Fishing and Aquaculture			
Invasive species and shipping			
Marine Renewable Energy			

2. Where do you live? How far is this from the coast or sea?

_____miles or km

3. On average, how many times a year do you visit the coast in your free time? *(a visit is any time (days) you choose to spend at the coast)*

_____days a year

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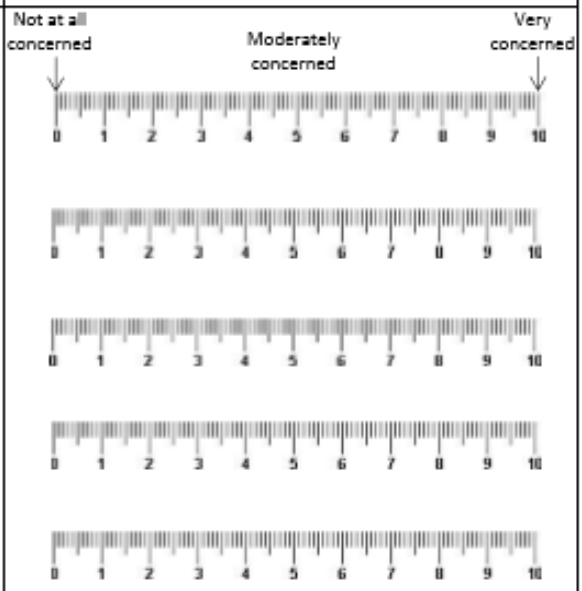
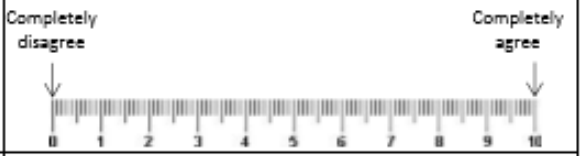
Section 1 Concern about the effects of people on the environment	
4. When you think of the coastline or sea, what is the most important environmental issue that comes to mind?	
5. On the scale to the right (0-10), how worried are you about the effects of this issue *(answer to Q above)*? *Place a mark between 0 and 10*	
6. On the scale to the right (0-10), how worried are you about the effects of the issues below? *How worried are you about the **effects of excess nutrients from the land entering the seas and oceans and causing eutrophication**?* *How concerned are you about the **effects of coastal tourism activities on the ocean environment?*** *How concerned are you about the **problems microplastics might cause in the ocean environment?*** *How concerned are you about **the effects of unsustainable fishing or aquaculture on the ocean environment?*** *How concerned are you about the effects of **invasive species (transported by shipping) on the marine life and environment in new areas they settle?***	
7. Do you talk about ways of helping to reduce human impacts on the ocean, with your family, friends, colleagues or teachers? *Please indicate on the scale of 0 (not at all) – 10 (all the time) to the right.*	
8. Have you supported an online petition or supported an environmental charity in the last year? If Yes, what was the topic?	YES / NO — *Topic or charity:*
Section 2 Information and knowledge about human – ocean impacts and benefits	
9. On a scale of 0-10, where **0 = completely disagree** and **10 = completely agree**, to what extent do you agree with the following statements? i) *"I have good knowledge about how human activity effects the ocean environment."*	
ii) *"I have good knowledge about how the ocean environment benefits people."*	
iii) *"For the topic that I learnt the most about, I feel confident that I know what actions I can take to reduce negative effects on the ocean environment"*	

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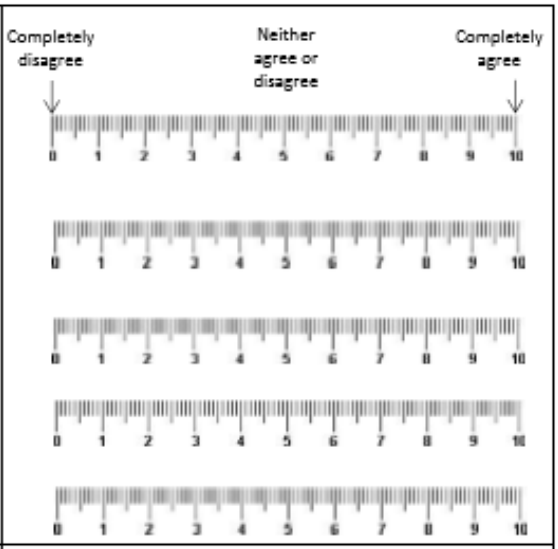
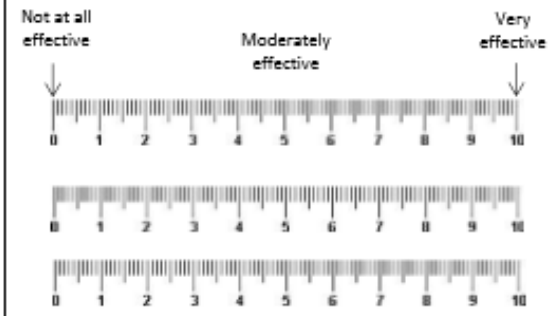
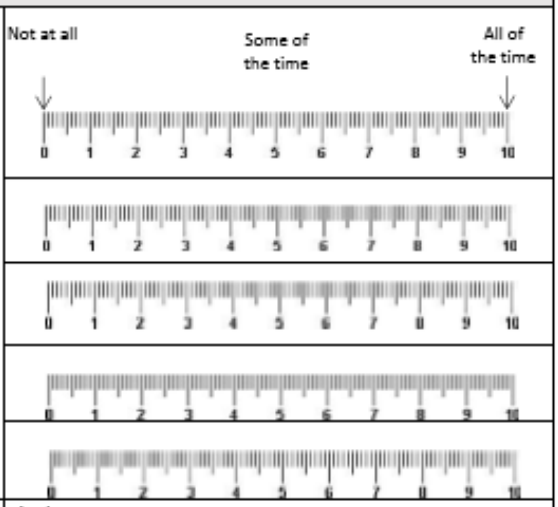
10. On a scale of 0 -10, where **0 = completely disagree** and **10 = completely agree**, to what extent do you agree with the following statements: a) *'I believe there will be a benefit to the marine environment and human health if I take actions to reduce human impacts on the sea.* *b) 'I am very worried about damage to the natural environment'* *c) 'I often feel disconnected from the ocean environment.'* *d) 'I always think how my actions will affect the ocean environment.'* *e) 'It makes me sad to hear about damage to the ocean environment.'*	
11. In your opinion, how effective are the options below at reducing impacts of human activities on the ocean*? (please indicate between 0-10 on the scale)* a) "Myself and others only buy products and take actions that limit negative impacts on the ocean environment." b) "Businesses and industries reduce their negative impacts on the ocean environment". c) "Governments support approaches that ban or reduce actions that have negative effects on the ocean environment"	
Section 3 Current Actions	
12. Which of the following options to reduce the negative effects human activities on the ocean*?* a. "I look for products that do not contain microplastics." b. "I choose sustainably sourced seafood" c. "I look for information on the farming practices used to produce my food (e.g. to reduce my nutrient footprint)." d. "I choose holiday locations, accommodation and, or tour operators that reduce their negative impact on the environment." e. "I sign petitions or join campaigns to reduce negative effects of human activity on the ocean."	
13. Do you undertake any other actions in addition to any in Q12? *(Please use the space to the right to explain what actions you take)*	Actions:
14. Where did you hear of solutions or actions to reduce the negative effect of human activities on the ocean?	

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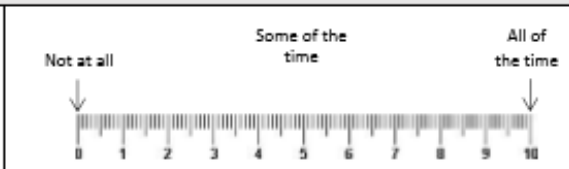
Section 4 Future Actions	
15. Which of the following actions will You pledge to do in the future? a. "I will look for products that do not contain microplastics."	
b. "I will choose sustainably sourced seafood"	
c. "I will look for information on the farming practices used to produce my food (e.g. to reduce my nutrient footprint)."	
d. "I will choose holiday locations, accommodation and, or tour operators that reduce their negative impact on the environment."	
e. "I will sign petitions or join campaigns to reduce negative effects of human activity on the ocean."	
16. Will you undertake any other actions in addition to any in Q12? *(Please use the space to the right to explain what actions you take)*	Actions:
17. Has the ResponSEAble information influenced the actions you intend to take in the future?	
18. What do you remember most from the ResponSEAble information you have seen?	
19. Which 2 audiences do you think the information in the interactive platform will have the greatest impact on? (*to help reduce the negative impacts we have on the seas and oceans)*	School (age 11-15) | School (age 16-18) | General public age 18+ | Industries | Retailers, supermarkets | Government Other: (please describe)
20. Do you have any suggestions to help improve the platform or tools on the platform?	
21. Please select your age category (*please circle*)	a) 11-15 b) 16-18 c) 18-24 d) 25-34 e) 35-44 f) 45-54 g) 55-64 h) Over 65
22. What is your gender?	Male | Female | Other | Prefer not to say

Please be assured that your details will remain completely confidential. In case you are interested in more information about the ResponSEAble project, and what will happen with the interview results, please contact matthew.ashley@plymouth.ac.uk or check for updates on the project website: www.responseable.eu

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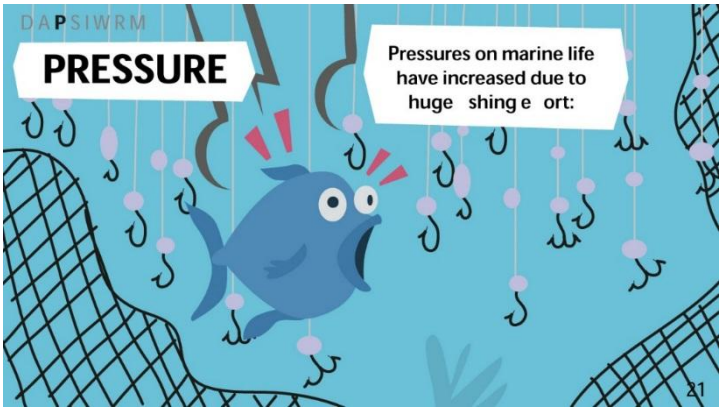
14. Annex 10: Animated cartoons



14.1 Ocean Literacy Objectives

The animated cartoons were designed to improve knowledge, raise awareness and provoke changes in behaviour around the six key stories of ResponSeable. Conceived as a series of 6 chapters, they tell a story in approximately 5 minutes addressed to the general public. They are uploaded in internet where people can find them while navigating, but can also be used as supporting material for different dissemination activities. Since they use simple language, animated images and short texts, they target adults, youngsters and children although the level of understanding in each age range will be different.

14.2 Overview of the Design and Development Approach

This Ocean Literacy tool could not be developed following a classic living lab process due to the limitations that producing a video or animation sets, meaning that we could not test a first version with our target public whose input served to improve the final version.

Instead, a first story board was outlined and given to the artist, who developed the cartoon by designing snapshots representing the different elements of the story to be told, after discussions and interactions with the scientists from ResponSEAble. This unanimated version was presented to the Steering Committee (SC) of the project, a group that is not strictly general public. After several iterations between the scientists, the SC and the artist, the cartoon was animated with music and movements of the characters, English was checked, and texts were translated into Spanish and Basque.

The story was developed following a DAPSI(W)R(M) model, a conceptual framework widely used to describe the links between human pressures and state-changes in marine and coastal ecosystems. In this framework, the term Driver refers to the basic human needs such as food, shelter, security, and goods. In order to obtain these, society carries out Activities (fishing, shipping, infrastructure building) which in turn create Pressures which are defined as the mechanisms whereby an Activity has an effect, either positive or negative. These effects, when on the natural system (the physico-chemical and ecological system) are referred to as State Changes, which can lead to an Impact on that particular ecosystem. Once this Impact occurs on the natural system then society is concerned that there will be a resulting change on human Welfare and on the ecosystem services. Those Impacts on human Welfare and State Changes on the natural system then need to be addressed using Responses. As the EU Directives refer to these responses as Measures then we can use the final term as Responses (using Measures). Those measures then include economic and legal instruments, technological devices, remediation agents, and societal desires.

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Since all the key stories deal with environmental issues provoked by human activities, DAPSI(W)R(M) model is a useful and graphic way to explain how human socioeconomic systems affect the marine environment and how its impacts can be mitigated. At the end of each cartoon, a suggestion of behaviour change, relatively easy to implement, is given.

The 6 cartoons (Alien Species, Microplastics, Tourism, Fisheries, Renewables, and Eutrophication) were uploaded to Youtube. The number of views of each cartoon (and it's URL) are shown in Table 14-1 and Table 14-2.

Table 14-1: Location and viewing figures for Alien Species, Microplastics, Tourism, Fisheries and Renewables cartoons

Cartoon	English	Spanish	Basque
Alien Species	**1552**	**1316**	**331**
	https://www.youtube.com/watch?v=rajH-qmUJg8 *Published: 6th September 2017*	https://www.youtube.com/watch?v=vw4KYzEuMJM&t=40s *Published: 6th September 2017*	https://www.youtube.com/watch?v=kEHx6PPIPMY&t=110s *Published: 12th September 2017*
Microplastics	**1288**	**4453**	**552**
	https://www.youtube.com/watch?v=TdbpYswVaz0&t=185s *Published: 2nd November 2017*	https://www.youtube.com/watch?v=KhPrHynr-7A *Published: 6th November 2017*	https://www.youtube.com/watch?v=1_lqumdo2SU&t=43s *Published: 21st November 2017*
Tourism	**796**	**604**	**117**
	https://www.youtube.com/watch?v=LRTQOvz4kts *Published: 3rd January 2018*	https://www.youtube.com/watch?v=dA8XGlqOcIs&t=6s *Published: 4th January 2018*	https://www.youtube.com/watch?v=b8rrrYdrbRA&t=4s *Published: 7th January 2018*
Fisheries	**268**	**482**	**169**
	https://www.youtube.com/watch?v=6Ml0AHcmn9Y *Published: 9th July 2018*	https://www.youtube.com/watch?v=rEtCBWemjkg *Published: 9th July 2018*	https://www.youtube.com/watch?v=tMAykMHOJE8 *Published: 9th July 2018*
Renewables	**195**	**125**	**41**
	https://www.youtube.com/watch?v=e644Qbzflko *Published: 22nd October 2018*	https://www.youtube.com/watch?v=vvGwdAplrD8 *Published: 29th October 2018*	https://www.youtube.com/watch?v=7BQuU3Va6zg *Published: 31st October 2018*

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Table 14-2: Location and viewing figures for Eutrophication cartoon

Cartoon	Eutrophication
English	**402**
	https://www.youtube.com/watch?v=PN59pt78cj0
German	**316**
	https://www.youtube.com/watch?v=eJzLUgin7Oo&t=67s
Latvian	**243**
	https://www.youtube.com/watch?v=ooUjdJAk6Mk
Estonian	**127**
	https://www.youtube.com/watch?v=oHioQw7DqyE
Lithuanian	**105**
	https://www.youtube.com/watch?v=9UYp7AaHCTQ
Polish	82
	https://www.youtube.com/watch?v=PtuCng4VA-8&t=34s
Russian	164
	https://www.youtube.com/watch?v=CbyvcqBHeaA&t=96s

14.3 Testing Undertaken

The first 5 cartoons were mainly tested as part of the Interactive Platform, and is documented in the relevant section. Further testing was undertaken by University Lusofona and INDD. However, in the table below we have included some statistics on the total views, likes, dislikes and comments made on the cartoons in the three languages.

It can be seen (Table 14-3) that, until 28th January 2019, a total of 12,460 people have viewed the cartoons (56.9% in Spanish, 33.2% in English and 9.9% in Basque). From the total of likes (170), the distribution among languages are pretty similar to the total views (35.3%, 58.2% and 6.5%, respectively). Only 5 ‘do not like’ were recorded for all cartoons, representing only 2.8% of the total responding about liking or not the cartoons. The most viewed cartoon, adding all languages, was that of microplastics (51.2% of all views), being the most viewed in Spanish and Basque, but in English the most viewed was that of alien species. Only 10 comments were registered, being 5 of them about alien species.

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Table 14-3: Viewing statistics for Alien Species, Microplastics, Coastal Tourism, Fishing and Renewables cartoons

Key Story	Statistics	English	Spanish	Basque	TOTAL
Alien	Views	1564	1330	334	3228
	Likes	26	24	4	54
	Dislikes	0	1	0	1
	Comments	2	3	0	5
Microplastic	Views	1298	4522	562	6382
	Likes	18	52	1	71
	Dislikes	0	1	2	3
	Comments	1	0	0	1
Tourism	Views	805	612	122	1539
	Likes	9	8	2	19
	Dislikes	0	0	0	0
	Comments	2	0	0	2
Fishing	Views	271	491	175	937
	Likes	3	12	4	19
	Dislikes	0	1	0	1
	Comments	0	2	0	2
Renewables	Views	199	133	42	374
	Likes	4	3	0	7
	Dislikes	0	0	0	0
	Comments	0	0	0	0
TOTAL	Views	4137	7088	1235	12460
	Likes	60	99	11	170
	Dislikes	0	3	2	5
	Comments	5	5	0	10

In the remainder of this section we document testing of the Eutrophication cartoon (Figure 14-1), carried out by BEF and UPM.

Figure 14-1: Views from the cartoon "Eutrophication in the Baltic Sea: a story of food and consumerism."

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14.3.1 Assessment methods

The cartoon 'Eutrophication in the Baltic Sea' was made available on the ResponSEAble website and 'Youtube' channel. Translations were available of a survey to gather before and after responses of general public viewing the cartoon to assess the effect of the cartoon on viewers self-reported knowledge about the topic, their attitude (concern) about effects of eutrophication in the Baltic Sea, their perceptions on which actors will be most effective in addressing the issue, and belief that there would be benefits from their own actions. Finally, the surveys assessed the current frequency participants undertook actions to reduce the impacts of eutrophication before viewing the cartoon, and the frequency afterwards. Responses to questions included providing agreement with statements or frequency of undertaking actions on a 0 -10 scale (0=not at all) (10 = very much so/all the time).

14.3.2 Assessment results

Eleven viewers of the cartoon completed surveys, across three countries, Germany (1), Estonia (3) and Latvia (7). Respondents were aged between 25 and 54, from a range of professions, 2 were environmental professionals, while the remaining 9 respondents were from a variety of professions ranging from book-keeping (3), construction (1), to graphic design (1). The vast majority of respondents were female (10).

Pre-existing environmental concern (see Figure 14-2) was high across respondents (mean 8.6 SE ±0.66), as was reported concern about effects of eutrophication (7.73 SE ±0.59). Following viewing the cartoon, respondents self-reported knowledge about environmental impacts of eutrophication was moderate (mean 6.18 SE ±0.76) and average self-reported knowledge about impacts of eutrophication on human health and wellbeing was also moderate (5.36 SE ±0.91).

Respondents showed high agreement (>7) that each of the actors stated (public, farmers, retailers and governments) taking actions to reduce the extent of farming practices that lead to eutrophication. Participants felt that government action, to ban or reduce farming methods that lead to excess nutrient run-off would be most effective (average level of agreement 8.18 SE ±0.48).

An increase in average frequency of respondents in undertaking communication to inform others, and all behaviour options / actions, to reduce the negative effects of excess nutrients entering the sea were reported between pre and post surveys. Although self-reported frequency was not above a moderate frequency (the anchor for between 4 and 6 was 'some of the time'), there was an increase for frequency for every action, and the largest increase occurred for 'informing others about eutrophication', 'look for information on what meat and dairy products to eat to minimise footprint' and 'buy or eat food with a low environmental footprint.'

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*Figure 14-2: Mean participant responses to pre and post surveys completed before and after viewing the Eutrophication Cartoon, significant differences (p=<0.005) between pre and post surveys are indicated by ****

14.4 Main findings

The key messages of the cartoon appear to have been taken up by the respondents, who appear to have already been highly motivated with high concern for the environment, and very high agreement (>8) with indicator questions on pro-environment attitudes) ('*Human impacts on the marine environment are a problem'* and, '*It makes me sad to hear about damage to the ocean environment*').

The increase in reported behaviour does not reflect the benchmark levels identified for Theory of Change targets for other tools (of post frequency being >7 and /or a significant increase between pre and post frequencies). However, for many tools the post survey referred to 'intended' frequency as surveys were undertaken very soon after interacting with the tool. In this instance the surveys was undertaken up to two weeks later, and requested actual frequency of behaviour since viewing the cartoon. Questions were phrased as 'I looked for', 'I chose' or 'I bought' rather than asking for an intention 'I will'. Therefore although frequency is lower the small increase is important as it provides a closer representation of actual behaviour.

Although the respondents appear highly motivated to act responsibly towards environmental issues, the messages and specifically the behaviour choices presented in the cartoon appear to have been remembered and undertaken more frequently by the respondents. Follow up data would be very valuable wit this group to understand if the increase in frequency of undertaking the behaviours has been sustained or even increased, or as decreased to previous frequencies.

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14.5 Future lessons

The respondents to voluntary surveys regarding ocean environment issues appear to already have very environmentally responsible viewpoints and attitudes. The cartoons appear effective at sharing messages, and specific behaviours or actions to this group but it will be important to also understand the effectiveness of the tools on members of the public / citizens who hold less supportive viewpoints or are not already aware of marine environmental issues and human-ocean relationships.

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15. Annex 11: A System Dynamics Approach to Increasing Ocean Literacy

15.1 Introduction

In this tool we created and tested a Simulation-Based Learning Environment (SBLE) that uses System Dynamics simulation to introduce and reinforce systems-based Ocean Literacy learning. Through the identification and use of systems archetypes and general systems features such as feedback loops, we can also test for the instilling of transferrable skills and the ability to identify, apply or create sustainable solutions.

15.2 Design and Development

The DAPSIWR 'stories' constructed were highly complex. The main difficulty we found was how to present this complex knowledge adequately without overwhelming the learner. During our research, we investigated a number of different approaches, including data visualisation techniques, the use of narratives, storytelling, 'story maps', guided and/or gradual display of the DAPSI(W)R, and web-based multimedia.

We concluded that the most promising approach was to take a Systems view. Finding and explaining the essential dynamics of the system helps to find order in the complexity, and can be done relatively economically. We chose one key story as a case study, Coastal Tourism, and analysed the human-ocean system underlying it, in order to find system structures such as feedback loops, stocks and flows, and system archetypes.

We set out to explore the possibility that learners' exposure to relevant system concepts, generic structures and systems archetypes would improve their mental models, so that they would be better able to understand and predict the behaviour of human-ocean systems. This learning would be implemented within a web-based SBLE.

Rather using the SBLE to offer participants a 'pre-cooked' explanation for an Ocean Literacy topic, we were interested in supporting learners in developing transferrable critical thinking skills, through increasing their knowledge and understanding of the applicable systems concepts.

Our approach was to identify those basic concepts which are essential foundations for effective system thinking and modelling. We then performed a mapping (Figure 15-1) between these basic concepts and the phenomena which exemplify them in the key story chosen as the sample system (Coastal Tourism). By developing an online software tool to lead the participant through a gradual introduction of the systems concepts and illustrating them within the context of the key story, we aimed to simultaneously impart systems thinking knowledge and improved knowledge and understanding of the key story (Coastal Tourism) itself.

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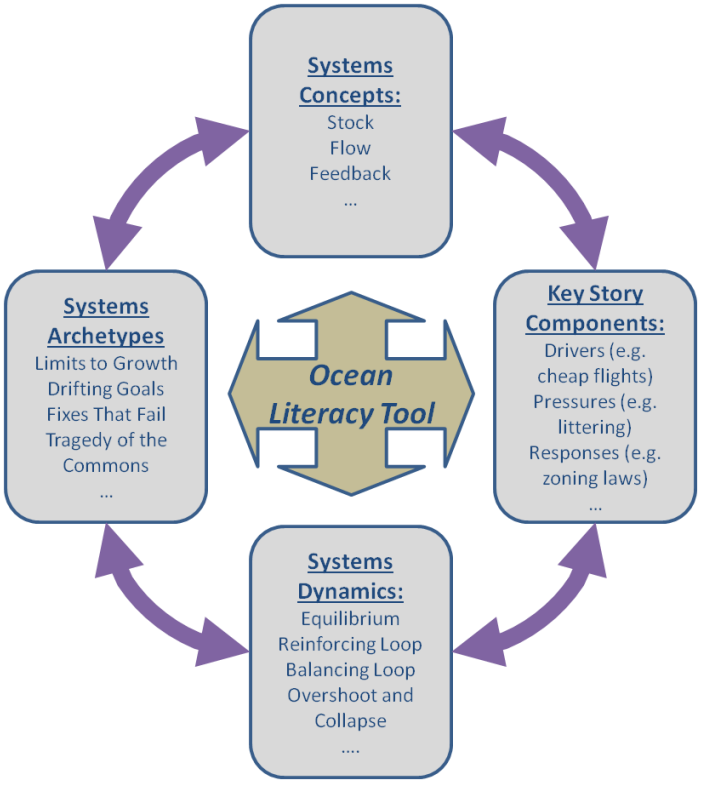

Figure 15-1: Systems Thinking and Key Story concept map

A key aim of the tool is that users are encouraged to experiment with and learn from the underlying system model by interacting with simulations, thereby both reinforcing their understanding of dynamic behaviour, and learning how to change system behaviour.

15.2.1 The System Simulation Learning Tool

We have developed the first version of a tool which is designed for a general audience. The tool is unique in using online simulation of a System Dynamics model as part of an Ocean Literacy tool. The user is led through a series of pages which introduce and explain the Coastal Tourism story in a gradual manner. Along the way, the user can play with progressively more complex simulation models and answer quiz questions which test their understanding of the contents covered in the tool, i.e. the story and the relevant system dynamics concepts underlying it.

Essential System Thinking tools and concepts are used to analyse the human-ocean system that encapsulates Coastal Tourism. Causal Loops Diagrams (CLDs) are central to the explanations (Figure 15-2). The model diagram is not displayed in the main pages, since it is potentially off-putting to the general user, but is available for interested users in the 'Extras' page. Fundamental Systems concepts are explained and explored, including stocks (Figure 15-3), flows and accumulation, dynamic equilibrium, feedback loops (Figure 15-4), loop dominance, Limits to Growth archetype (Figure 15-5), structure determines behaviour, leverage points, system goals, renewable versus non-renewable resources (Figure 15-6), and sustainability.

A systems view of the Coastal Tourism problem

A key Systems Thinking learning objective is to invite understanding of the connection between a positive feedback loop and exponential growth. Central to our systems-orientated analysis of the Coastal Tourism problem is that the unchecked growth of tourism that occurs when profits are reinvested back into tourism creates a positive feedback loop which leads directly to the exponential growth of tourists. This exponential growth is inherently unsustainable and is a powerful driver

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for the damage caused both to the natural environment and to the human environment if unchecked. It is powerful enough to lead to the collapse not only of environmental quality, but also to tourism at the resort in some conditions.

Key leverage points are explored, such as advertising level, growth of hotels and tourist infrastructure, and investment in the environment, in order to explore ways to bring the system into a sustainable state. Participants can use simulations to actively explore (Figure 15-7) the effects of changing these key variables, and can practice doing so with the goal of bringing the system towards sustainability, a system state that is described as one where tourism can continue over time, rather than peaking and then collapsing, within a healthy coastal and human environment.

In the simulations, users can change variables and immediately observe the effects on key stocks, such as numbers of tourists and environmental quality (Figure 15-3). They also receive instant feedback for answers they give to each test question. Their answers are captured and downloadable in CSV form for analysis.

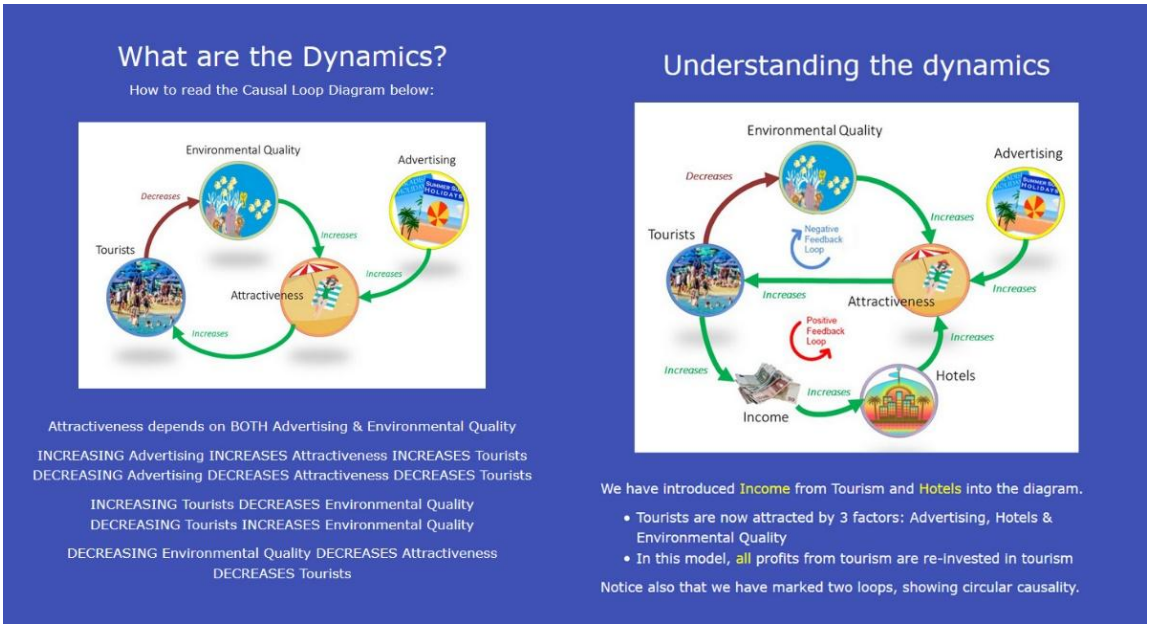

Figure 15-2 Ocean Literacy tool screenshot: two versions of Causal Loop Diagrams for Coastal Tourism, part of a series that build in complexity (RQ1)

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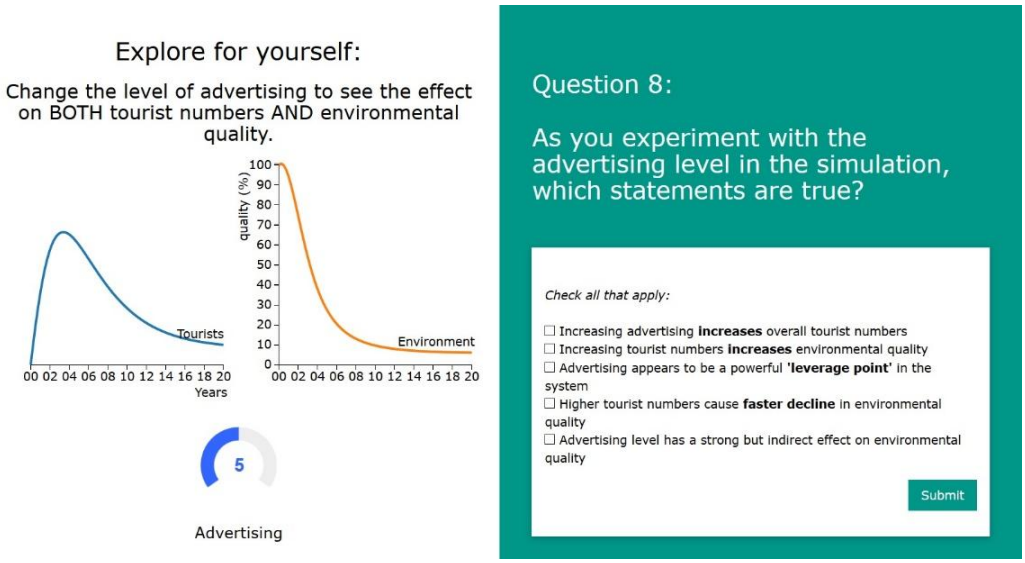

Figure 15-3 Ocean Literacy tool screenshot: simulation showing two key stocks (Tourists and Environmental Quality) and a pivotal model variable (Advertising Level), together with a reinforcing in-tool quiz question (RQ1)

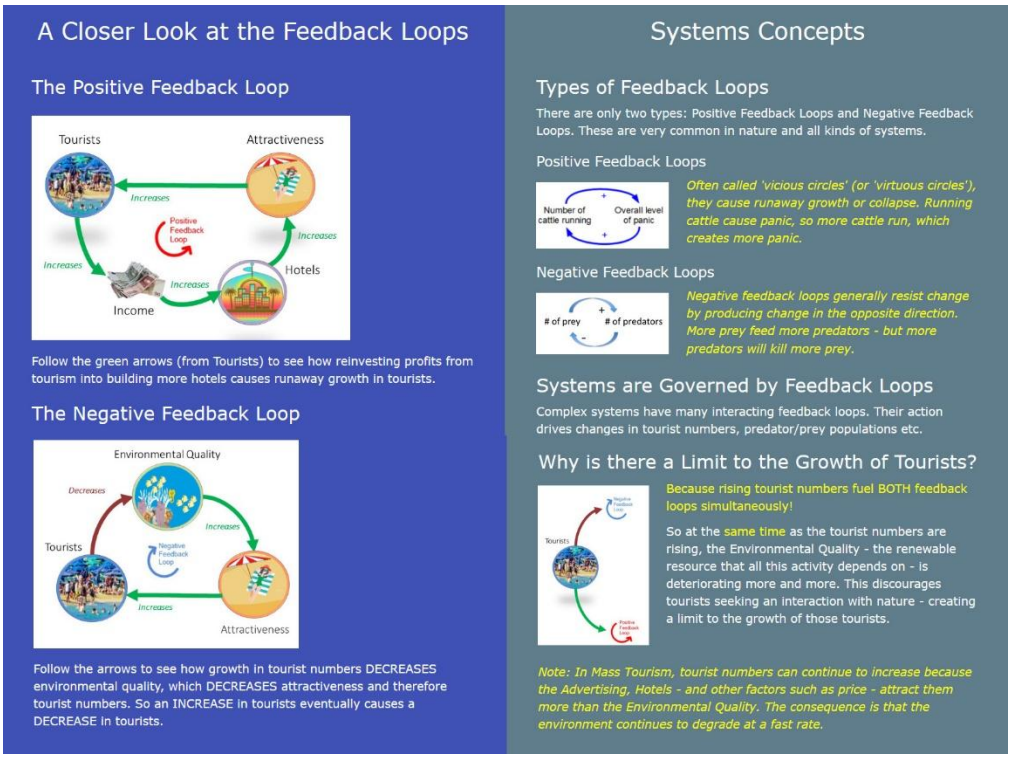

Figure 15-4 Ocean Literacy tool screenshot: Feedback loops explained, both in the context of the Coastal Tourism model, and in general Systems thinking terms (RQ1)

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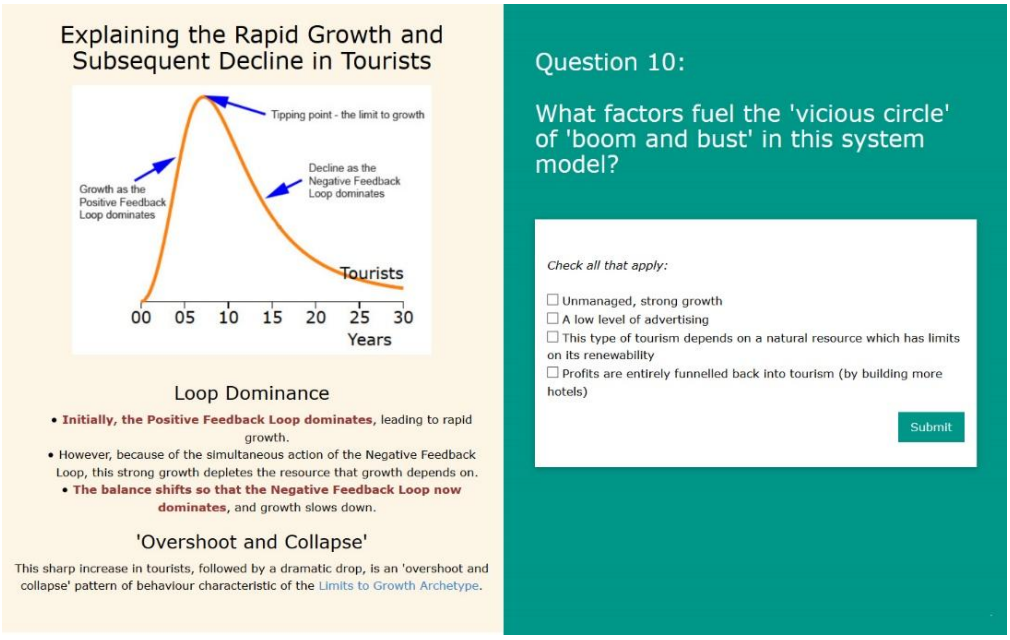

Figure 15-5 Ocean Literacy tool screenshot: introduction to the Limits to Growth Systems Archetype and its relevance to Coastal Tourism, together with a reinforcing in-tool quiz question (RQ2)

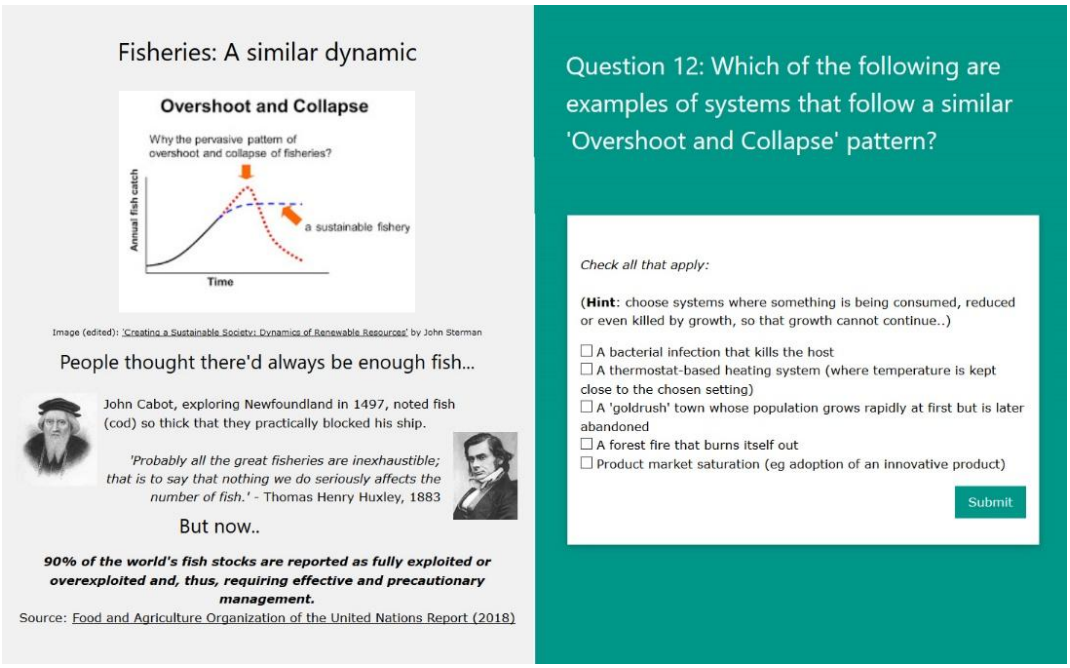

Figure 15-6 Ocean Literacy tool screenshot: application of the Limits to Growth Systems Archetype to a second human-ocean system (Fisheries), and an in-tool quiz question to test recognition of the same archetype underlying other systems, encouraging development transferable skills (RQ2)

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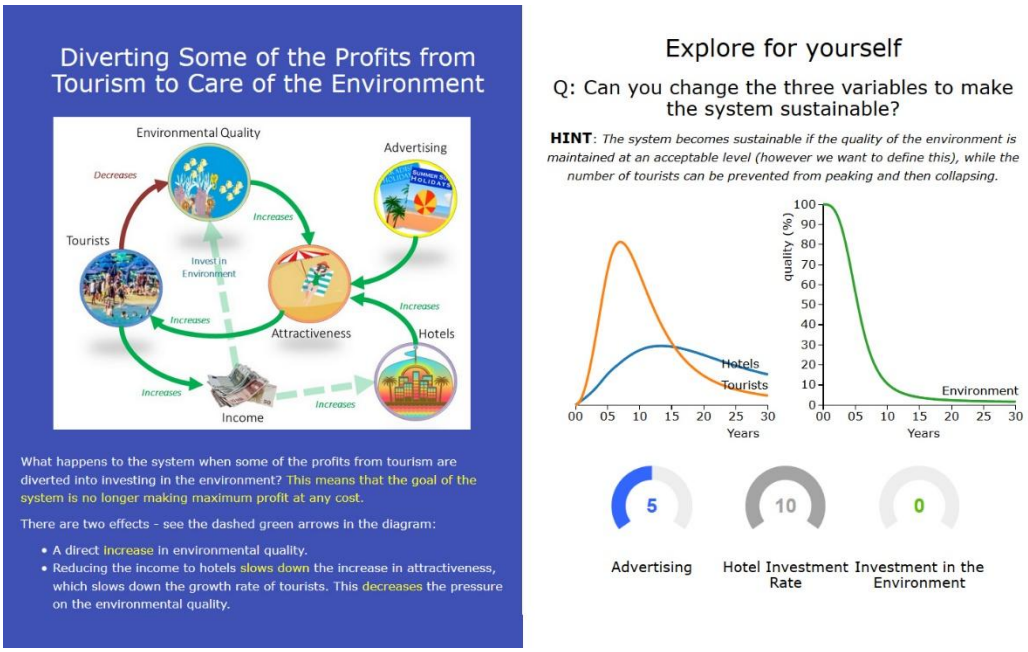

Figure 15-7 Ocean Literacy tool screenshot: illustration of changing the system structure for sustainability, and a simulation giving users an opportunity to practice bringing the system into a sustainable state by manipulating model variables (RQ3)

15.2.2 Models and Software used

The tourism model on which the simulation is based was adapted from the generic, normalised Simulation Model Z412B, in Hartmut Bossel's System Zoo 2 (Bossel, 2007). Several models were built from this, starting with simplified partial models, gradually building up their complexity. The models were created in Stella Architect (the original Bossel model is in Vensim format) and exported to XMILE[5] format (an emerging standard for storing and sharing System Dynamics models). The XMILE format is required for the in-browser simulation tool, sd.js[6]. This is an open source library for fast, in-browser simulation and display of an animated model diagram. The software libraries jQuery and Bootstrap were also used to implement interactive variable controls and responsive layout respectively.

15.2.3 Ocean Literacy content

The prototype online interactive Simulation-Based Learning Environment (SBLE) centres on one key story – Coastal Tourism – and highlights the similarity of the system dynamics inherent in another key story, Sustainable Fisheries. The source material is based on the Key Story DAPSIWR analysis documented during the ResponSEAble EU project.

15.2.4 Teaching Environment

We designed this platform for use in combination with face-to-face teaching individually or in groups, following best practice for SBLE's (Landriscina, 2013a) and Systems teaching (Fisher, 2011). The initial testing reported in this paper was done with a mixed group of 15 adults from different backgrounds, in one-to-one sessions with a facilitator available at all times for guidance as necessary. The participants took an average of 40 minutes to work through the tool, and another 30 minutes in total filling in pre- and post-test surveys and giving qualitative feedback.

[5] https://www.oasis-open.org/committees/xmile/

[6] https://github.com/sdlabs/sd.js

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15.2.5 Learning Objectives

A set of learning objectives was established for the key story (Coastal Tourism), comprising the relevant Ocean Literacy knowledge, systems knowledge, and the knowledge required for identification of sustainable solutions (see Table 15-1).

Table 15-1: Ocean Literacy and Systems Thinking Learning Objectives Identified

Page	Title	Learning Objectives	OL/Key Story Learning Points	Systems Thinking Principles; Application
Intro	Introduction	Traditionally, coastal tourism in Europe has been based on the so-called 3S model: sea, sand and sun. But the massive increase in tourist numbers, especially in Europe, is devastating the coastal environment and causing decline in traditional local employment and quality of life. These tourist numbers are on a continuing upward trend.	The Human-Ocean System is a complex system [*OLP 6*].	Systems Thinking provides major insights for tackling complex, practical problems like these.
1	The Natural State of the Coastal Environment	The natural coastal environment renews itself naturally. It can deal with naturally occurring degeneration, to maintain a consistently healthy state - a constantly changing, but stable, state known as 'dynamic equilibrium'. Apply Systems concepts to see Environmental Quality as a stock, and degeneration and regenerate rates as flows. Understand that EQ is affected only by these flows. Think about how human activities affect these flows.	Equilibrium disturbed Degeneration rate caused by tourism exceeds natural regeneration rate?	• Stocks • Flows • A stock changes only according to its flows • Accumulation of Stock according to Net Flows • Dynamic Equilibrium • Environmental Quality identified as a Stock • Regeneration and Degeneration Rates identified as Flows
2	Mass Tourism and its Effect on the Coastal Environment	Massive and ongoing increase in tourist numbers internationally. Europe the most popular destination. Latest global tourism figures. Direct (inverse) causal relationship between tourist numbers and environmental quality. Examples of damaging effects of coastal tourism. Typical characteristics of mass coastal tourism.	Environmental stresses caused by Tourism, and Mass Tourism in particular [illustration of OL6D].	• Tourists increase Degeneration Rate (outflow of Environmental Quality) • Tourists therefore decrease Environmental Quality
3	Countering the Effects of Mass Tourism on the Coastal Environment	Exploring some responses to try to reduce the damage done by costal tourism. Classification of responses according to whether they affect Degeneration or Regeneration Rates. Ask the question: are responses like these enough, or is wider system change needed?	The Human-Ocean System is a system [*OLP 6*]. Much of the world's population lives in coastal areas [OLP 6F].	• What is a System? • What is Systems Thinking? • System Structure determines Behaviour • Leverage Points
4	Case Study: A Coastal Resort Where Nature is the Main	Analysis of a particular type of resort: one which attracts nature-loving tourists, such as snorkelling resort. If the fish disappear, so too will the snorkellers. Advertising brings in tourists, who then degrade	The Effects of Human Activity on the Ocean [*OLP 6D*]. Our Responsibility	• Causal Loops Diagrams • Feedback Loops • Identify chain of causality (indirect causation) • Advertising level identified as a Leverage

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Page	Title	Learning Objectives	OL/Key Story Learning Points	Systems Thinking Principles; Application
	Attraction	the environment. Tourist numbers initially rise quickly, but then fall, because the attraction was nature-based.	[*OLP 6G*].	Point
5	Uncontrolled Growth	Hotels and profits from tourism are added to the model. Tourists are now attracted by 3 factors: advertising, hotels & environmental quality. All profits from tourism are re-invested in tourism in this model. This leads to uncontrolled and unsustainable growth. Explanation of why this type of growth often follows a 'boom to bust' pattern, and leads to serious environmental damage.	The ocean sustains life on Earth and humans must live in ways that sustain the ocean [OLP 6G].	• Positive and Feedback Loops: the only two types • Identification of Feedback Loops • Systems are Governed by Feedback Loops • Loop Dominance • Limits to Growth: Feedback loops cause rapid growth and subsequent collapse in tourists, because environmental quality, a renewable resource, is depleted
6	Systems Thinking for Sustainable Tourism	Understanding that the Overshoot and Collapse pattern in nature-based tourism is a common system pattern of Systems behaviour. Its characteristic 'crash' can be avoided. The usefulness of developing transferable Systems skills in order to identify and fix common Systems problems. Identifying renewable resources.		• Dynamics of the 'Overshoot and Collapse' generic Systems structure • Comparison with another HOS: Fisheries • Learning to identify other systems exhibiting similar behaviour • Learning from Systems Thinking: Applying known strategies to fix systems of similar structure
7	Towards Sustainability	Definition of Sustainable Development and Sustainable Tourism. Three aspects: environmental, economic and social. Simulation-based practice at bringing the System into a sustainable state, where the quality of the environment is maintained at an acceptable level (however defined), and the number of tourists can be prevented from peaking and then collapsing.		• Herman Daly's Rules for a Sustainable Society • Changing System Goal as key Leverage Point • Changing System Structure as key Leverage Point: eg introducing new feedback loops, weakening or strengthening existing loops

15.2.6 Data Captured

Pre- and Post- test surveys

Before using the OL tool, the participants completed a survey which assessed their current level of awareness, concern (attitude), knowledge of, behaviour towards, and communication about, topics related to the key story in question (in this case Coastal Tourism).

After use of the tool, participants completed a post-test survey consisting largely of the same questions as the pre-test, in order to assess effectiveness of the tool.

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Qualitative feedback interviews

The facilitator observed and noted user interaction with the tool and gathered verbal feedback both during the training and afterwards in a moderated feedback session (structured around key questions).

Answers to in-tool questions

There were 13 multiple-choice questions embedded in the tool. Answers to these were captured and stored on the NUIG ResponSEAble server, and downloadable in CSV and JSON format for analysis.

15.3 Evaluation Methodology

15.3.1 Assessing potential for Behaviour Change

The ultimate aim of the Ocean Literacy tool is behaviour change. Unfortunately, this is difficult to measure directly. However, it is possible to measure predictors of behaviour. To assess effectiveness of the Ocean Literacy tool, the OL dimensions were integrated with predictors of behaviour change as described in the Section 3.

Table 15-2 shows the relationship between the ten predictors of behaviour change, the Ocean Literacy dimensions, and the corresponding questions used in the pre- and post- surveys for assessing the effectiveness of the OL tool.

15.3.2 Theory of Change logic Model

A Theory of Change logic model (Table 15-3) was completed in collaboration with social and behavioural science researchers at the University of Plymouth and ProSea tool developers.

In the ResponSEAble project, tools were applied to specific Ocean Literacy topics (key stories) and target audiences. The tools embodied specific responses or behaviour change objectives. Therefore, assessment aims to make sure that tools are as effective as they can be at furthering the goals of ocean (or marine) citizenship, namely, to tackle large-scale and seemingly insurmountable international problems (Fletcher and Potts, 2007). The intention is that after use of the tools, participants will adopt behaviours and make lifestyle choices that support the sustainable use of the marine and coastal environment.

Predictors of behaviour change and Ocean Literacy dimensions can be assessed using research techniques such as surveys, repeated pre and post interaction with the Ocean Literacy tool (Phal and Wyles, 2014). In order to assess change over time, the same questions can be asked before and after interaction with the tools, and again during longer follow-up studies as necessary.

Questionnaire surveys were conducted with course participants before and after interacting with the Ocean Literacy tool. Each survey question addressed an objective within the Theory of Change framework and therefore an Ocean Literacy dimension. Scale based questions (0-10) assessed whether a change in awareness, knowledge, attitude, social and personal norms (communication) and reported or intended behaviour had taken place.

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Table 15-2: Relationship between questions developed to assess effectiveness of the Ocean Literacy tool, Systems Thinking for Coastal Tourism, predictors of behaviour and Ocean Literacy dimensions assessed.

Predictors of behaviour (Klöckner, 2013)		**Ocean Literacy Dimensions Applied in assessment** *(text in brackets indicates an indirect connection)*	**Questions used in pre- and post-intervention survey** (0 (*not at all*) – 10 (*a lot/very*) scale based responses, unless otherwise shown)
Best direct predictors of behaviour	**Intentions** ("I will do this.")	• **Behaviour decisions, choices, actions, and habits** • **Activism**	*Note: These 4 questions initially assess current behaviour ('I…') (in pre-test), then intended behaviour ('I will…') (in post-test):*
			'When on holiday on the coast I (will) separate litter for recycling.'
			'When on holiday on the coast, I (will) look to use businesses that reduce their negative impact on the environment.'
			'When planning a holiday on the coast I (will) look for towns or resorts where council officials have introduced schemes to reduce negative impacts from tourism.'
			'I (will) look for information on sustainable tourism practices that I can undertake in the areas I visit.'
	Perceived behaviour control ("It is up to me whether I do this rather than other people or contextual factors.")		'I believe there will be a benefit to the marine environment and human health and happiness if I support sustainable tourism activities (e.g. recycling & using businesses that limit their environmental impact).'
	Habits (behaviours that have become automatized through repetition.)		On average, how many times a year do you visit the coast in the country where you live in your spare time? *(No of times)*
			In the last three years, how many times have you been on holiday abroad to a coastal resort? *(No of times)*
			If so, which regions did you visit? *(circle regions)*
Factors having an indirect effect on behaviour	**Attitudes** (favourable or unfavourable evaluations.)	• **Attitude**	What do you think are the biggest causes of problems facing coastal resorts? *(rank 5 items listed)*
	Norms (what is seen as commonly done by others.)	• **Communication**	How often do you (will you) talk about ways of helping to reduce the problems coastal tourism may cause in the ocean with your family, friends, colleagues or teachers?
	Responsibility (ascriptions of who should deal with the problem.)	• (Attitude)	Not assessed.
	Awareness of consequences (knowledge about impacts.)	• **Knowledge**	'I have good knowledge about how coastal tourism activities affect the marine environment.'
			'I have good knowledge about how coastal tourism

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			activities may affect human health and happiness.'
		• **Awareness**	When you think about Coastal Tourism, what are the most important environmental issues that come to mind? *(Please list between 1 and 3 issues)*
	Values (general trans-situational goals such as equality or individualism.)	• (Attitude)	What were your criteria for choosing a particular coastal resort? *(please put your most important reasons first)*
	Negative and positive emotions (such as worry or hope.)	• (Attitude)	'I am very worried about damage caused by Coastal Tourism to the natural environment'
			How worried are you about the effects of the most important environmental issues that came to mind?
	Whether people see themselves as environmentalists.	• (Attitude) • **Activism**	'I support projects to restore coastal and marine habitats that have been degraded by coastal development'

Table 15-3: Theory of Change logic model developed to assess effectiveness of OL tool.

Ocean Literacy – Behaviour Change: Theory of Change	Problem Awareness	Knowledge	Attitude	Interpersonal Communication / Social Norm	Barrier Removal	Behaviour Change
Theory of Change: AIM	Following the intervention, participants will be aware of the issue or problem in the key story.	Following the intervention, knowledge about the issue (key story) will have increased.	Following the intervention, attitude towards the issue will have changed, and change in behaviour supported. Participants feel the response action will be effective.	Following the intervention, participants will communicate about the issue or topic with friends, family and at work.	Barriers that prevented the behaviour change will be reduced / removed.	Behaviour adopted or intention expressed:
Coastal Tourism example	i) Tourists to recognise threat to marine environment. ii) Tourists to recognise threat to human health and happiness.	Tourists to recognise: i) Coastal Tourism has increased massively since the 1950s. Over 500 million tourist arrivals in the Mediterranean are expected by 2030. ii) Types of damage done to the environment (damage to habitats, ecosystems, biodiversity, pollution etc) iii) Types of damage done to the human environment	Tourists believe / recognise that: i) Mass tourism causes damage to the coastal and local human environment ii) Making sustainable tourism choices will reduce this damage, eg recycling, not littering, choosing eco resorts.	1) Tourists will communicate with friends and family, colleagues and teachers about i) The threat of mass coastal tourism to the health of the marine environment and to human wellbeing. ii) The options to reduce this damage. 2) Tourists will seek	Knowledge of options or actions that reduce the damaging effects of coastal tourism. Belief that participants can make a difference.	1) Tourists to seek and choose sustainable forms of coastal tourism. 2) Tourists to behave in environment ally conscious ways when on holiday, eg recycling, conserving water, not littering. 3) Informed tourists to support

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		(congestion, waste, overcrowding, urbanisation, water consumption, local industries etc) iv) Some responses to reduce the damage, eg recycling, waste water treatment, community initiatives, responsible tourism. v) Understanding System dynamics eg powerful positive feedback loop caused by uncontrolled growth in tourism. vi) Moving towards a sustainable solution by reducing growth and investing in the environment.	iii) Supporting projects to restore coastal environments will also help.	information (internet, social media, books, magazines, newspapers, friends, family, expert advice) on the topic of sustainable tourism.		initiatives to repair coastal environments and encourage tourism businesses to reduce their negative impact.
Measurable objective (indicator)	Pre- and post-survey – Analysis over time.	Pre- and post- survey – Analysis over time.	Pre- and post-survey – Analysis over time.	Pre- and post-survey – Analysis over time.	Pre- and post-survey – Analysis over time.	Pre- and post-survey – Analysis over time. (Survey results of intended / reported behaviour).
Result (from pilot study) (mean # pre – mean # post, on a scale of 0 (not at all) to 10 (a lot / very)	Awareness was assessed qualitatively: an increase in number of issues listed by participants post-intervention, a greater emphasis on the need for sustainability and investment in the environment, increased awareness of the need to enforce regulations on coastal tourism development.	67% increase in mean self-reported knowledge of the damage done to the natural and human environment by coastal tourism was recorded between pre- and post-survey (4.6 -7.7). This relates to points ii and iii above. The other points were not directly addressed but the topics were covered in the tool, and informed other survey responses.	18% increase in mean level of participants' reported worry about the damage caused by Coastal Tourism to the natural environment (7.2 – 8.5).	142% increase in mean level of how often participants currently do (pre-test) and intend to (post-test) communicate about ways of reducing damage caused by coastal tourism (2.6 – 6.3).	14% increase in mean level of participants' response that they 'believed there would be a benefit to the marine environment and human health and happiness' if they support sustainable tourism activities (7.8 – 8.9).	88% increase in mean level of participants' intention to undertake actions to reduce the damage done by coastal tourism (4.3 – 8.1).

15.4 Results

15.4.1 Initial results of pilot study

The Systems Thinking for Ocean Literacy tool was piloted with 15 adult participants (9 women and 6 men), eleven of whom were PhD students, one retired local council manager, a Masters student, an engineering graduate, and a teacher. Ages ranged from 18-24 to 55-64, with the majority (two thirds) in the range 35-54.

Using the pre- and post- test surveys, we were able to capture a significant amount of information regarding the test subjects' Ocean Literacy.

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Participants' initial attitude levels were quite high before the intervention, meaning that they were already worried about the damage caused by coastal tourism. They did not often communicate about these issues, however. They had only moderate confidence in their knowledge about how coastal tourism affects the marine and the human environment. They were only moderately likely to take action to reduce the negative effects of coastal tourism (behaviour).

Increase in predictors of behaviour change were observed for each OL dimension used in the framework (Figure 15-8).

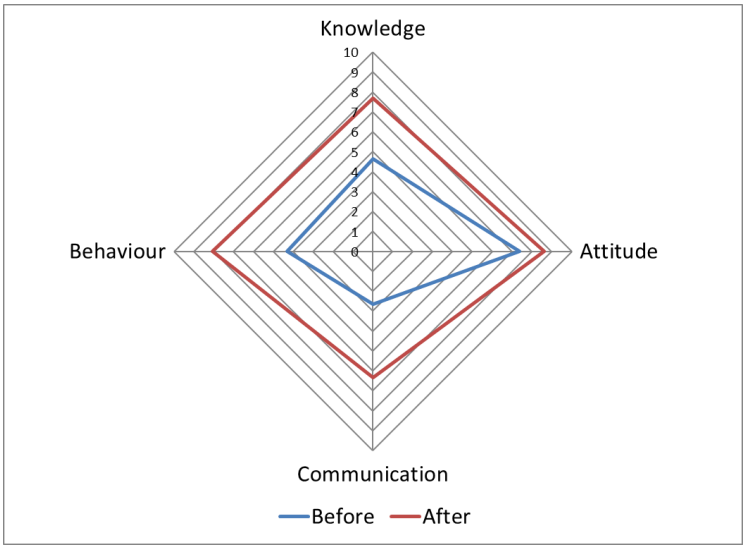

Figure 15-8: Radar chart showing changes in 4 of the dimensions of Ocean Literacy before and after use of the tool

The largest increases were seen for how often participants intend to communicate about the effects of coastal tourism on the marine and human environment, their intention to take action to reduce the negative effects of coastal tourism (behaviour), and their self-reported level of knowledge about the issues.

Participants' responses to survey questions showed a 142% increase in mean level (0 not at all – 10 all the time) of how often participants currently do (pre-test) and intend to (post-test) communicate about ways of reducing damage caused by coastal tourism.

An 88% increase in mean level (0 not at all – 10 all the time) of participants' intention to take action to reduce the damage done by coastal tourism was recorded in the post-test survey. Survey responses indicated participants were motivated to undertake behaviours and were provided with information to enable them to carry out actions. Furthermore, regarding their criteria for choosing coastal holidays, many participants did not think much it, and did not record their criteria in the survey, but if they did, they chose on the basis of facilities (including sun/sea/sand) and cost. After using the tool, there were more varied responses given, and a marked change in priorities for planning intended future coastal holidays: environmental quality or impact, and sustainable or responsible tourism, were most often given as criteria. Follow up surveys will be important to find out if intended behaviours and actions were carried out, and what were the enabling factors or barriers.

A 67% increase in mean self-reported knowledge of the damage done to the natural and human environment by coastal tourism was recorded between pre- and post- survey. There was some evidence of a richer understanding of the concept of sustainable coastal tourism (in terms of dynamics and balance).

Awareness was assessed qualitatively: survey responses showed an increase in the number of issues listed by participants post-intervention, a greater emphasis on the need for sustainability and investment in the environment, and an increased awareness of the need to impose regulations on coastal tourism development.

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There was an 18% increase in how concerned participants felt about the effects of coastal tourism on the marine environment. This lower increase does not mean that the tool was less successful in this regard, since the pre-test level of concern was higher than for all the other OL dimensions. There was also a 14% increase in mean level of participants' response that they 'believed there would be a benefit to the marine environment and human health and happiness' if they support sustainable tourism activities.

'Cohen's d' (Cohen, 1988), is a statistical measure of the effect size, calculated by taking the difference between the two means (here, pre- and post- survey results) and dividing by the pooled standard deviation (i.e. the root mean square of the two standard deviations). 0.20 is considered a small effect, 0.50 is medium, 0.80 is large, and >1.20 is very large. Applying Cohen's d to our results is encouraging, as demonstrated in Table 15-4.

Table 15-4: Effect Size of Ocean Literacy dimension changes

	Mean Before	Std Dev Before	Mean After	Std Dev After	Cohens d	Result
Attitude (Barrier Removal)	7.78	2.71	8.87	1.56	0.51	Moderate positive effect
Knowledge	4.64	1.93	7.68	1.52	1.81	Large positive effect
Attitude	7.16	2.26	8.50	1.61	0.71	Moderate positive effect
Communication	2.63	2.77	6.33	2.55	1.45	Large positive effect
Behaviour	4.31	3.44	8.08	1.61	1.45	Large positive effect

Finally, all participants found the simulations useful for improving their understanding of the dynamics of the Coastal Tourism system. When asked what they found most memorable about the tool, most participants cited interacting with the simulations and discovering the dynamics of the system.

15.4.2 Opportunities and limitations identified in the pilot study

The results of pilot study data presented above summarise percentage change of mean value for participant's responses between pre- and post- course surveys. The use of percentage change can be misleading where there was already a strong positive response to a question. Bar charts of mean values and error bars would better display consistent strong agreement between pre and post surveys. For instance, participants scored highly in questions testing attitude prior to participation in the tool (mean 7.2). After participation response to this question provided the strong agreement (mean 8.5), but a comparatively moderate percentage increase of 18%. It is also possible that, since participants were aware that they were participating in a Coastal Tourism OL initiative, this may have influenced their answer towards what was felt to be 'expected' in pre- and post- surveys.

Follow up surveys, to identify whether participants have undertaken intended behaviours, together with enabling and inhibiting factors will provide valuable data on long term behaviour change. The online tool also collected data on participants' location, age, gender, occupation and highest educational qualification. The surveys collected data on current behaviour as regards trips to the coast locally and on holidays abroad. The data has not yet been analysed. Responses of the final surveys could be analysed in relation to these factors to investigate the level of influence they have on participant's responses and predictors of behaviour change.

Results of the pilot study are encouraging. The tool and teaching methods can be refined according to the qualitative feedback obtained during the initial study, and a full trial conducted with a larger number of participants.

In order to provide evidence that a Systems approach increases effectiveness, use of a control group should be considered. This group would interact with a similar tool without explicit Systems concepts and simulations.

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15.4.3 Data from in-tool quizzes

The in-tool quiz questions served mainly to provide learning challenges for the participants, to help them engage and practice applying new OL and Systems concepts, and the recorded answers to help us, as tool developers, to obtain feedback and thereby improve the efficacy of the presentation approach.

One third of participants gave incorrect answers for reading the Causal Loop Diagrams. As discussed below in the qualitative feedback section, this is an area for improvement in the tool.

Participants scored well (13/15 correct) on the question testing their understanding of how to bring the coastal tourism system to a sustainable state (RQ3). They also scored better than expected (11/15 correct) when identifying systems with similar structure (archetype) (RQ2). They scored less well (8/15 correct) when asked to identify factors that fuel a 'boom and bust' ('overshoot and collapse') dynamic. This part of the tool therefore needs further work.

15.4.4 Qualitative feedback and observations made while participants interacted with the tool

Regarding the quantity of material: A number of people found that following the tool required too much reading and concentration. Sections should not be too long. Respondents took an average of about 45 minutes to work through the material and answer questions. Many of them commented that this was too long. 20 – 30 minutes would be acceptable.

Use of systems terminology such as stocks and flows, feedback loops: Some participants thought this was off-putting. But teaching Systems thinking without using them may be ineffective. The use of an alternative, simpler set of terms, and assessment of their usefulness, would be an interesting topic for research. One participant said that the Systems concepts were the most challenging. One participant reflected out loud – are we educating people about Systems Thinking and/or System Dynamics (to improve Systems Literacy in general), or are we trying to educate them in a specific domain (in which case the less jargon the better?). Another said that the system is designed too much around academic concepts and would lose members of the general public. Another thought that it did take a lot of concentration but that having to think about the 'learning points' meant that she learned something of value.

Different needs of different types of user, from general public to technical: For general users with no knowledge of ST/SD it might be hard for them to stay focused all the way to the last page. What exactly is the intended audience? This needs to be better defined.

Visual versus textual content: A number of participants wanted more visual material (video, animation or slideshow with voiceover), instead of long sections of text and static diagrams. More interaction would help keep users engaged. A narrator with a strong storyline would help.

Response to in-tool quiz questions: Participants' reaction to these varied. A majority became visibly worried about 'getting answers wrong'. Others found the reinforcing of learning from material on the page useful. A few said they enjoyed the challenge. Some questions and answers caused confusion and needed clearer wording.

Understanding of dynamics of the system: Most people gained a new understanding of the importance of the major drivers in the human-ocean system under investigation, for example, the effect of huge increases in tourist numbers, and the powerful effect of feedback loops.

Difficulty with Causal Loop Diagrams: Reading CLDs caused a bit of confusion, mainly with regard to how to read the arrows. We annotated arrows with 'increase' and 'decrease' – e.g. A increases B, which means 'As A increases, B increases'. But if A *decreases* instead, then users need to understand that B will *decrease*. There are a number of alternatives for annotating CLD arrows, but none easily solve this problem. For the next version of the tool some form of novel presentation such as animation should be considered, or use of a short teaching video clip. For example, users could hover over an arrow to get both senses of its meaning. One participant suggested letting users practice creating their own causal loops.

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Issues with the models underlying the simulations: Some participants pointed out flaws with the simulation models, for example, unexpected behaviour of stocks (tourists, hotels or environmental quality) when variables were set at extremes, i.e. at minimum or maximum values. Models need to be thoroughly tested at the extremes in order to avoid causing potential confusion for learners. Our models, as are Bossel's, are normalised, i.e. unit-less. They are useful for showing general dynamic trends but some users commented on the lack of y-axis scales on some graphs, and the lack of concrete figures. It may be useful to provide a detailed model for a specific coastal resort so that concrete figures and scales can be displayed.

Facilitation versus unsupervised self-study: Most people thought that a facilitator would be preferable for this type of material. Alternatively, facilitator sessions could be recorded and video clips included in the tool for each major topic.

Learning by using the simulations: Most people found the interactive simulations useful and enjoyable to use. Learning by experimenting is effective and can give unexpected results. The last simulation in the series attracted a lot of positive comment. In it, users attempt to manipulate three variables in order to bring the system to a sustainable state. The most interesting suggestion was that it should be possible, after attempting the task, to display a pre-prepared answer (variables would be set for a sustainable outcome, visible on the graphs).

Perceived limits of the influence of the public: One participant pointed out that policy changes are needed, as well as actions by individuals, in order to reduce the damage caused by coastal tourism. The systems view arguably emphasises the policy ('big picture') point of view.

Sample of spontaneous feedback during post-tool interviews:

'Genuinely eye-opening, much more concerned about the problem than before.' [Increased awareness/attitude of concern].

An interesting response to pre-questionnaire behaviour questions: 'If I'm on my holidays, I'm on my holidays!' – meaning, I don't want to have to think about recycling and being environmentally responsible. [Reveals attitude].

'It's both too easy and too hard at the same time. It requires a level of concentration people probably won't want to give.' People would need to be motivated by interest in the subject. 'Could be used as a teaching tool by a facilitator.' [Comments by a teacher].

Some comments left in-tool:

'Understanding how to work towards Sustainable Tourism has opened my eyes to what I can do to help.'

'Good resource - this is engaging, it made me think, taught me a little about Systems Thinking, raised my consciousness about choosing holidays and amenities that have a sustainable approach, and a concern for the environment.'

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16. Annex 12: Social Media Campaigns

A Social media campaign is a coordinated effort aimed at reinforcing or assisting some specific communication goals using social media channels.

A SM campaign must:

1. Focus on a specific and well-defined topic;
2. Target a well-defined public;
3. Produce measurable outcomes (e.g. in terms of people reached and engaged).

Due to these characteristics, it differs from everyday activities on ResponSEAble SM profiles, which are rather part of the overall dissemination strategy of the project (WP6).

Based on the activities from WP1-2-3-4, the project identified the more suitable key stories for the social media campaigns. The Partners decided to focus on Coastal Tourism as the first SM campaign and to set up a second campaign on Eutrophication and agriculture.

The scheduling was proposed as follows:

- Coastal Tourism: launched in Feb 2018 *(described in Section and D5.2)*
- Eutrophication: launched September 2018 *(described in Section 16.2)*

16.1 Social Media Campaign on Coastal Tourism

The Social Media Campaign on Coastal Tourism is fully documented in D5.2 (Social Media Presence and Campaigns). The following is a summary of the findings of this first Social Media Campaign (SMC).

The design of **the Coastal Tourism SMC** followed the following principles:

Channels: the campaign took place mostly on Facebook and Instagram (for reaching the youngsters) due to their supposed capacity to reach a larger audience; Twitter and Linkedin were used as support to spread the campaign. Before the campaign (24 of January 2018), the FB ResponSEAble page had 835 followers;

Geographic scope: the key story on coastal tourism originally focused on the Mediterranean Sea, and in particular, on France, Italy and Greece. However, a SM campaign aiming to reach the general public must be developed in national languages. Therefore, due to the resource constraint, only one country will be selected for this pilot, and this will be Italy: in fact, this is the country where the ResponSEAble page has the most followers, so it was easier to test our strategy for this pilot campaign. A similar campaign (translating all contents from the Italian pilot) might also be developed for France in the coming months.

Topic of the Campaign: in the three weeks of the campaign, the campaign focused on Coastal Development, Marine Litter and Natural Ecosystem.

16.1.1 Ocean Literacy Objectives

Regarding the **Coastal Tourism Campaign** the OL Objective was to promote a “ResponSEAble” tourism able to respect and protect our coasts; to achieve this, the following specific objectives were identified: **increase awareness of coastal litter and impact of coastal tourism, increase awareness/knowledge of sustainable tourism practices and illustrate good practices/examples of improvements in sustainable tourism. On this basis, the key message to be conveyed by the SM campaign was defined as follows:**

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The beauty of our holiday beaches depends also on our choices as tourists, consumers and citizen – thus on choices that we make not only when we are visiting these places, but all year round!

In order to achieve the general objective, the campaign invited people to think of their favourite beaches and natural coastal spots in the middle of winter in order to remind the sense of beauty, wonder, relax (and other positive feelings) linked to the marine environment and it will provide tips and guidance on those behaviours which have a positive impact on beaches, in order to increase awareness on 1) how can they contribute to, maintain, or increase the beauty of their favourite beaches through their everyday choices and 2) what can they do all year round.

As for regarding the target, the Coastal Tourism Campaign focused on tourists, and more specifically on two "digital personas" named Roberta and Sergio representing "common" tourists, i.e. people going to the beach every year who are not dealing with research, who might or might not have environmental awareness or knowledge.

The planning of the contents for the Coastal Tourism campaign was intended to deal with different dimension of the OL:

Knowledge

- 4 Infographics were published on the ResponSEAble page to provide information on the four topics: Coastal Erosion, Plastic and Microplastics Pollution, Marine Litter, Coastal Development and Mass Tourism. The idea was to use a visual communication in order to share very concise factual data;

Attitude & Behaviour

- 8 Memes were published on the ResponSEAble Facebook on the four topics: Coastal Erosion, Plastic and Microplastics Pollution, Marine Litter, Coastal Development and Mass Tourism. The idea was to create something that could generate a viral process, using humour and acting on emotional aspects.

Activism

- A call to action to engage users and attract them towards the ResponSEAble Facebook page – a photo challenge was set up as a call to action with the hashtag #7daysofsummer. The idea is to involve people in sharing their holidays' photos in order focus on beauty and remind them how it is important to act in everyday life to protect the marine environment.

16.1.2 Testing Undertaken

The Social Media Campaign on Coastal Tourism was carried out in the first three weeks of February 2018. During this period, the produced contents were published on the ResponSEAble Facebook page.

The campaign was also promoted on the other social media profile of the project, and more specifically on Twitter, Instagram and Linkedin spreading the #7weeksofsummer hashtag and inviting people to join the photo challenge.

During that period, on the FB page continued the publication of curated contents about Coastal Tourism, and in parallel the VideoContest, promoted by TVE was going on. This parallel activity lead benefits to both the campaigns.

The efficacy of the single post was monitored and in general, there was a significant increase of the interactions on the SM channel, in terms of reactions (like, love, sad, etc.). However people didn't make many comments and also the rate of participation to the photo challenge was not very high.

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16.1.3 Lessons Learned

Planning a SM campaign requires a creative and strategic thinking and a clear and consistent message, also if on Social media like Facebook some spontaneity is good, to stay relevant and to engage other people.

You have to define who your target is and produce specific content to engage it; the content need to share the same graphic content in order to be recognizable.

The publications of the contents have to be carefully planned in order to cover different time zones and publics; possibly the same message should be rephrased in different way in order to act on different needs, following the Maslow Pyramid (Safety, Belonging, Esteem/Prestige, Self- Actualisation).

All the contents of the campaign have to be tied together with a consistent hashtag (like “SeaDialogue” “7daysofsummer”)

Two months ahead are the minimum requests for preparing contents and the involvement of the experts is vital in order to pass the right messages.

Some other aspects to be planned are the use of paid advertisements in order to be more effective in targeting the right users.

16.2 Social media campaign #KeepTheBalticBlue

Eutrophication in the Baltic Sea is a well-known environmental threat for several decades. However, as the DAPSIWR analysis in the key story Eutrophication & Agriculture demonstrated, the connection between the food system, the daily choices of peoples nutrition and the ecological status of the Baltic Sea are communicated only very rarely to the general public.

The social media campaign #KeepTheBalticBlue aimed at raising awareness and informing consumers in the Baltic Sea Region that their choice of food makes an impact to the Baltic Sea and that they have a voice as consumers and citizens to make a change.

16.2.1 Design and Development approach

The SMC took place in September 2018 and lasted for three weeks with daily posts on Facebook and Twitter and 2-3 posts per week on Instagram.

To reach as many people as possible, ResponSEAble reached out to the environmental NGO network Coalition Clean Baltic to join with their partners. In total 17 NGOs and interest groups from the countries Germany, Latvia, Sweden, Estonia, Lithuania, Belarus, Poland and Russia joined. All post texts were translated into 7 languages: English, German, Latvian, Estonian, Lithuanian, Polish and Russian.

The campaign contained three pillars:

1. What is eutrophication?
2. Where does eutrophication come from?
3. Which solutions exist to solve eutrophication?

Generally, it moved from (1) to (3) over time, but in a rather iterative process, so that people who joined later in the campaign and have never heard about the topic before, could follow the contents easily. Every day, the posts focused on one fact within the three pillars.

To engage people to inform themselves and/or to act, different formats were used to communicate the facts:

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1. Information (e.g., “Did you know that…?”)
2. Quiz (e.g., “Which country is the…?”)
3. Challenge (e.g., “Try to eat vegan today!”)
4. Be a detective (e.g., “Investigate your fridge…?”)
5. Sharing is caring (e.g., “Invite your friends for…”)

To motivate enhanced engagement and to provide further information, most posts were linked to other OL tools about eutrophication and agriculture:

1. The cartoon “Eutrophication in the Baltic Sea - a story of food and consumerism”
2. The video “Tackling eutrophication”
3. The story map “Eutrophication in the Baltic Sea - revealing linkages to our food system and consumption”
4. The infographic “Eutrophication in the Baltic Sea - the causes and solutions lie in our food system”
5. The blog post “Keep the Baltic Blue! Combating eutrophication in the Baltic Sea by intensifying the communication about consumerism” (Figure 16-1)
6. Short video clips.

To motivate people to follow the entire campaign, it contained 3 quizzes. In the last week, 10 awards - a voucher for a vegetarian/vegan restaurant, each - were announced and sent out to the winners.

Figure 16-1: Facebook post from the Social Media Campaign #KeepTheBalticBlue.

16.2.2 Ocean Literacy Objectives

The Social Media Campaign intended to address three objectives:

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1. Raising awareness of the society in the BSR on the connection between the food production/trade sector, the Baltic Sea and our own consumption pattern.
2. Create a readiness to change behaviour by increasing the knowledge about the drivers and potentials to act.
3. Raising attention that target groups are having voices and votes to impact policy making.

16.2.3 Testing undertaken

At the end of the campaign, a statistical analysis by Facebook Insights provided the following statistics: about 179000 people were reached, about 6800 post clicks and about 2850 likes were counted. The vast majority of the 230 comments were cross-linking the posts to other Facebook posts. During the campaign, the cartoon was viewed in total 1070 times (in different languages), the film 372 times, the story map 369 times and the blog 1455 times.

Questionnaire surveys to assess respondent's knowledge, attitude and behaviour in relation to the messages within the campaign and associated tools were made available online and as part of the campaign. After the campaign, followers were asked to fill the surveys, and we received 43 answered questionnaires.

16.2.4 Lessons learned

The major challenge was that the topic itself is difficult to communicate as the results of eutrophication are often not visible to people, or people have become so used to it that they consider dense algal blooms in the Baltic Sea as normal.

Having the campaign been setup in different countries revealed that cultural backgrounds (social psychological factors) must be understood, and the postings must be tailored to them.

Viewing through the comments revealed that touching the topic "food consumption" is challenging and may provoke resistance, due to people's often emotional connection to it. For example, followers became emotional when the post mentioned that the bad status of the Baltic Sea is connected to the high meat and dairy product consumption (e.g., "Meat eaters are the death of the planet!", "Even the Dalai Lama eats meat!"). Lesson learned: too intensive or aggressive posting scares people away.

16.2.5 Guidance for future development of Social Media Campaigns

Cultural backgrounds and social psychological factors must be assessed and understood beforehand and postings must be adapted to it in language, content and layout.

Simplifying the posts is important, e.g. only little text, few hashtags, few colours and emojis.

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17. Annex 13: Story map “Eutrophication in the Baltic Sea - revealing linkages to our food system and consumption”

The story map is meant as a platform to update the story of eutrophication in the Baltic Sea. Similar to as in the other OL about eutrophication, it wants to show the close relationships between the Baltic Sea and citizens, farmers, policy makers and retailers. It aims to highlight opportunities for change to mainly advanced learners, through better communication and cross-sectoral cooperation.

17.1 Overview of the Design and Development approach

The story map informs about the agricultural value chain and how it impacts the ecological status of the Baltic Sea. It reports about stakeholders and actors as well as their roles and responsibilities to act within the food system.

To tell about the impacts of the food system in a comprehensive approach, the story map starts with the chapters: (1) Agriculture in the BSR, (2) The Baltic Sea, and (3) The agricultural food system. Thereafter, it explains how communication is a key to raise capabilities of stakeholders to act by communication, with the chapters: (4) Storytelling about eutrophication, and (5) Opportunities for change.

The Story map was designed in a semi-interactive way, containing (geographical) maps where different aspects appear in different orders and colours when scrolling through it. Flow text, maps and a video show up in alternating orders. As shown in Figure 17-1 we see on the left the starting view and introduction. On the right we see nitrogen concentrations in the Baltic Sea Region, and below, insights into the agricultural value chain.

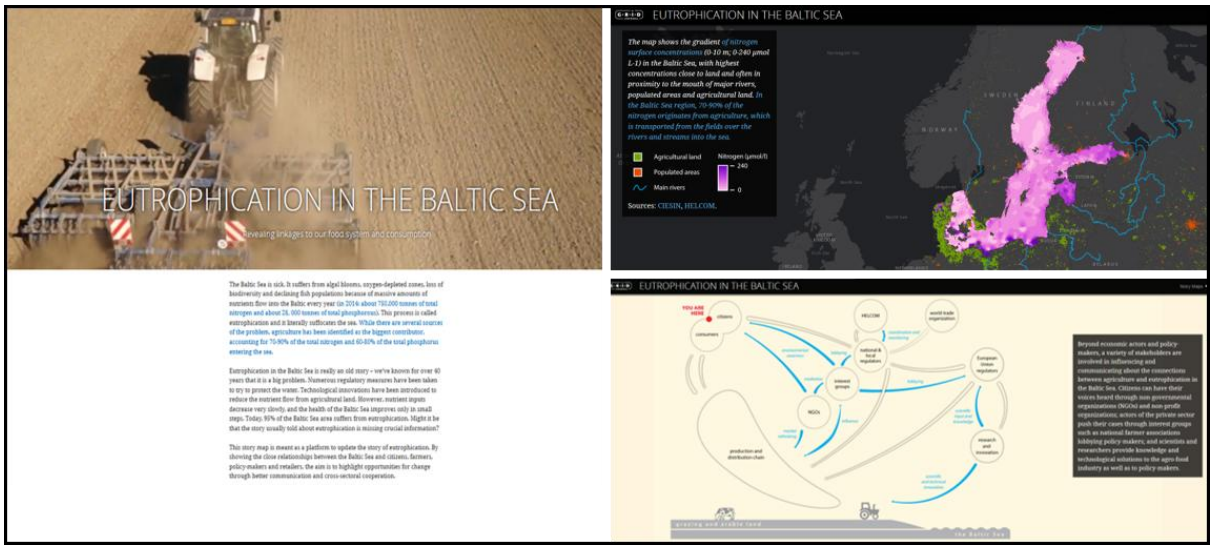

Figure 17-1: Detailed views of Story Map “Eutrophication in the Baltic Sea: Revealing linkages to our food system and consumption”

17.1.1 Ocean Literacy Objectives

The Story Map targets mainly advanced learners, who had heard about eutrophication in the Baltic Sea before and want to deepen their knowledge about its causes and consequences. It aims at:

- Increasing knowledge about how the food system causes eutrophication in the Baltic Sea, and about the actors and stakeholders involved in the value chain

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- Raising awareness about how the topic is communicated in public and how communications and cross-sectoral corporations must improve to combat the issue.
- Raising awareness that all actors and stakeholders in the agricultural value chain must change their behaviour and proposes, how.

Table 17-1: Theory of Change logic model for Ocean Literacy objectives identified for the Eutrophication Story Map

	Problem Awareness /Knowledge	**Problem Awareness /Knowledge**	**Attitude**	**Attitude – belief in benefit from own action (self-efficacy)**	**Interpersonal Communication / Social Norm**	**Behaviour Change**
Theory of Change: AIM	Following the intervention participants will be aware (informed) of the issue or problem in the key story.	Following the intervention knowledge about the issue (key story) will have increased.	Following the intervention attitude towards the issue would have changed, and change in behaviour supported.	Following the intervention participants feel the response action will be effective (there will be a benefit).	Following the intervention participants will communicate about the issue or topic with friends, family and at work or school.	Behaviour adopted or intention expressed:
Measurable objective	After using the story map, i) participant's Self –reported Knowledge about how excess nutrients form he land effect the marine environment will be >7. ii) If pre course response is <7, there will be a significant increase between pre and post surveys responses.	After using the story map participant's Self –reported Knowledge about the effects of eutrophication impact human health and wellbeing will be >7. ii) If pre course response is <7, there will be a significant increase between pre and post surveys responses.	i) After using the story map, average participant's agreement to the statement: '*How concerned are you about the effects of excess nutrients from the land entering the ocean environment'* on a scale 0 'not at all' (concerned) to 10 'very concerned', will be ≥7 (greater than moderate agreement). ii) If pre course response is <7, there will be a significant increase between pre and post surveys responses.	i) After using the story map, average participant's responses to the statement: *'I believe there will be a benefit to the marine environment and human health if I buy and eat foods that have been farmed responsibly.'* (0-10 scale) will be ≥7. (greater than moderate agreement). ii) If pre course response is <7, there will be a significant increase between pre and post surveys responses.	i) After using the story map, average participant's responses to the statement: *'How often will you talk about ways of helping to reduce problems from excess nutrients from the land may cause in the ocean.'* on a scale 0 'not at all' (undertake the action) to 10 'all the time', will be ≥7 (greater than moderate frequency). ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.	After using the story map, mean response of participants will be ≥7 for at least 1 of the intended behaviour options to '*help reduce the negative effects of excess nutrients from the land entering the sea,'* ii) If mean pre course response is <7, there will be a significant increase in (intended) frequency of undertaking the action.
Indicator result (objective achieved (Y/N))	Pre- Post - survey responses **(Y)**	Pre- Post - survey responses **(Y)**	Pre- Post - survey responses **(Y)**	Pre- Post - survey responses **(Y)**	Pre- Post - survey responses **(N)**	Pre- Post - survey responses i) **(Y)** but only one option with an average response '7'**,** ii) **(Y)**

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17.2 Testing undertaken

Testing was undertaken with undergraduate students studying for marine science related degrees. All students were living in a coastal city (Plymouth, UK) during the university year. This sample group were identified to meet the criteria of 'advanced learners' that the Story Map tool was designed to meet.

Thirty-three students aged between 18 and 24 undertook both a before and after survey. Students were provided an introduction to the tool and project and after being provided information on the informed consent process, those that opted to be involved in the research completed the 'pre' survey. Students then were provided a link to the online story map in an email and asked to spend as much time as required to use and review the tool. The following day, after reviewing the story map, and the links within it, the students completed an after survey. The before and after survey instruments repeated questions relating to the Ocean Literacy dimensions identified in the Theory of Change logic model constructed for the Eutrophication Story Map (Table 17-1).

17.3 Results

All Theory of Change objectives were met apart from for the dimension 'communication, social/norm,' (Table 17-1). Participants average general environmental concern was already high in the pre (before) survey >7 (Figure 17-2). Participant's concern for effects of excess nutrients on the sea and beliefs that action from all actors, including general public, farmers, retailers, governments and themselves, would be effective to reduce or cope with eutrophication were also high before interaction with the tool (Figure 17-2: Mean participant responses to pre and post surveys completed before and after using the Eutrophication Story Map, significant differences ($p=<0.005$) between pre and post surveys are indicated by ***). In post surveys the average frequency participants reported they would undertake behaviour actions was only >7 for one option '*support projects and farmers using farming practices to reduce nutrients being washed into the sea.'* However, there were significant increases in average frequency participants intended to undertake four of five other behaviour options (Figure 17-2). Knowledge of effects of eutrophication on human health and wellbeing also showed a large increase between pre and post surveys.

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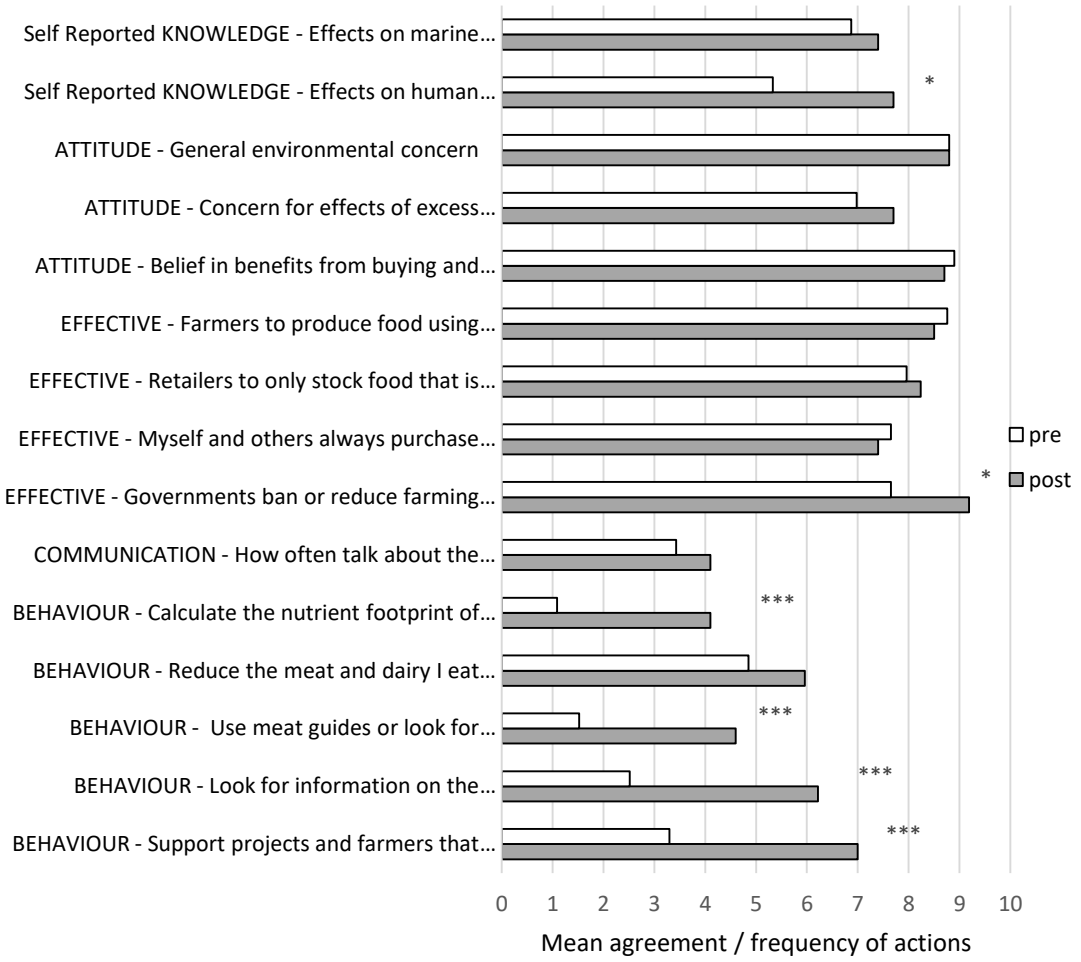

*Figure 17-2: Mean participant responses to pre and post surveys completed before and after using the Eutrophication Story Map, significant differences (p=<0.005) between pre and post surveys are indicated by ****

17.4 Lessons learned

Results of the pre and post surveys display that the students felt the Eutrophication story map, and the material the story map linked to, increased their knowledge of how effects of Eutrophication impact human health and wellbeing. Knowledge of actions that could be taken also appeared to be new to many students, as average frequency of undertaking behaviours was very low in the pre surveys. This is surprising for a motivated group of participant's with high concern for the environment and belief in benefits from taking actions. However, it is important to consider that the key story and Eutrophication case studies were focused on the Baltic sea and semi enclosed seas which the participants did not have contact with in their daily lives. In fact common responses to the question '*What do you remember most from the ResponSEAble information you have seen,'* were '*the extent of the problem in the area (Baltic)'* and the *'extent of Baltic sea affected'* and '*GIS maps of Baltic showing nitrate and phosphate levels and population concentration with major rivers'.*

The students group's knowledge about the biological and chemical processes relating to eutrophication, was likely to be high, as it is studied as part of the degree courses they were undertaking. The Eutrophication Story Map was a useful addition to the group's learning, as interaction appears to have raised awareness and knowledge about the extent of the problem, and the impacts on human wellbeing. The student group also suggested increased intention to undertake behaviours to reduce the negative effects of eutrophication in their daily lives. Greatest intended frequency included for

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the actions of ‘checking the farming practices used to produce their food’ and ‘supporting farmers and projects that aimed to reduce nutrients being washed into the sea’.

The participants saw some benefit from all actors taking actions to reduce negative human-ocean relationships related to eutrophication and farming. The group, who were studying marine science and conservation degree topics, showed greatest agreement, by far, (mean 9.2) that government action, to ban or reduce farming practices that lead to high nutrient run-off, would be most effective. There was high agreement that individuals taking action may have an effect but ultimately not every citizen would and policy and legislation that prevented the cause would be most effective across society.

The information contained in the story map was viewed by lecturers and course leaders as being of benefit as it provided case study material that effectively demonstrates the processes being taught in the university module.

As with other tools, the survey only approaches intended behaviour and being able to follow up using objective indicator data or follow up surveys would greatly benefit assessment of behaviour change.

17.4.1 Guidance for future development of Story Maps

The greatest challenge with applying and testing the Eutrophication Story Map with advanced learners in a university environment was ensuring the material was relevant to the modules and courses the students were studying. As time tables are very full, development of tools designed for advanced learners would benefit from early consultation with lecturers and course leaders to ensure the material and topic is compatible with taught subjects. This will benefit use and uptake of tools. The benefit from such consultation is that tools can then be included with lectures and teaching materials in multiple years and reach the most people.

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