ProBleu

Deliverable D3.1

Data-collection and citizen-science tools for education on oceans and freshwater

Requirements and design of a catalogue of ocean- and water-literacy teaching aids

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Summary

This report describes the efforts of D3.1 (Data-collection and citizen-science tools), part of WP3 (Accessible teaching support for ocean and water learning), and led by Earthwatch. It outlines the potential of citizen science practices in increasing ocean and water literacy at a classroom level, and describes the support available in this regard. Furthermore, educators themselves have been surveyed to garner their needs and requirements in regards to the ProBleu platform, and the resources available on it. As such, this deliverable will inform further work that takes part within WP3, specifically the development of the ProBleu platform (led by PML).

ProBleu is dedicated to enhancing ocean and water literacy in schools by creating a dynamic framework for sharing a variety of innovative teaching aids. These resources integrate the latest scientific insights into water literacy curricula, bridging classroom learning with real-world environmental challenges. The teaching aids encompass citizen science methodologies, scientific data from models and Earth observations (such as satellites), and virtual ocean-research journeys led by field scientists.

This deliverable aims to elaborate on data collection and citizen science tools for educators use and reference. This is an important step as it is crucial to understand educators specific needs and how they can effectively engage with relevant resources. This involves identifying the particular requirements and challenges educators face in teaching ocean and water literacy, and determining the best practices and resources that can facilitate effective teaching in this domain- which this deliverable aims to do. D3.1 achieves this by analysing a survey conducted by Plymouth Marine Laboratory (PML) and Earthwatch, which assessed the current availability of resources and pedagogical methods among educators.

Additionally, D3.1 explores available citizen-science tools that aid in data collection related to water and oceanic studies, evaluating their suitability for educational settings to ensure they are practical and beneficial for classroom activities. Section 4 elaborates on this by providing a list of digital academic resources and their summaries. The deliverable also mentions the Probleu online platform that caters to the needs of educators by providing educational resources and tools. This document also outlines the process of co-designing these editable online teaching aids and testing them with educators to create a comprehensive catalogue focused on environmental and citizen science. Collecting feedback on the usability and functionality of the resources shared through this platform will help to refine and improve the overall teaching experience. Lastly, this deliverable talks about the proposed next steps to be taken. The document outlines the key milestones envisioned till 2025.

List of abbreviations

NEBS - Network of European Blue Schools

WP - Work package

NGOs - Non-governmental organisation

UNESCO - United Nations Educational, Scientific and Cultural Organization

Introduction

Oceans and freshwater systems influence all aspects of human life, yet they are increasingly threatened by environmental change. The overarching objective of ProBleu is promoting ocean and water literacy. Besides several broad actions to promote, encourage participation in, and increase the diversity of the Network of European Blue Schools (NEBS), ProBleu is in the process of generating digital teaching content in an accessible and shared catalogue. We envision a 'catalogue of teaching aids', (co-)designed to ensure broad uptake. The first steps in this process, leading to an initial design concept, are described in this report.

The ProBleu approach, through individual school projects, emphasises real-world engagement, encouraging collaboration between educators and experts in scientific communities, public or industrial organisations to enrich the educational experience. Through ProBleu, students are empowered to participate in hands-on scientific research and data collection activities, bolstering their understanding of aquatic ecosystems and instilling a sense of stewardship for these vital resources. By linking classroom learning with real-world environmental issues, ProBleu helps students see the tangible impact of their studies and motivates them to take action in their communities.

This report (**D3.1: *Data-collection and citizen-science tools for education on oceans and freshwater***) includes the following main topics:

- Understanding the needs of educators related to ocean and water literacy, particularly how they could engage with the abovementioned resources.
- Understanding what citizen-science tools for data collection in the water domain are available and suitable for classroom use.
- Understanding the needs of educators related to ocean and water literacy.
- Design of an online sharing framework to meet these needs.
- Collecting feedback on the usability and functionality of teaching resources shared through this platform.

An important part of the initial design phase is to understand the technological and resource requirements of educators. This is addressed through an initial survey of educators involved in ProBleu-funded school projects.

The process of co-design and testing with educators will continue throughout ProBleu. A requirements-based portfolio of teaching aids is in production, and will be shared among users in the second year of the project. The catalogue of teaching aids will ensure access to the most relevant ocean and freshwater resources and datasets, linking evidence used in the international research community advising on the crises of climate change, pollution and biodiversity loss to traditional forms of teaching. The ProBleu platform will deliver dynamic and interactive tools to educators and students to explore and deepen their understanding of the functioning of marine

and freshwater systems and their response to environmental change and anthropogenic disturbance. The catalogue of teaching aids will provide an overview of teaching and learning goals and example scenarios to analyse. This approach will be suitable for teaching topics ranging from basic principles to complex interactions between climate, ecology, and human activities, either as a stand-alone project or embedded within the overall storytelling of environmental science in general and of oceans and waters in particular.

In the final sections, we detail the actions taken thus far and outline the future steps, leading to a technical design for the presentation and sharing of new resources developed to aid educators in designing projects, lesson plans, and analysing and collecting data.

1. Background

Both oceanic and freshwater systems play critical roles in maintaining ecological balance and supporting life on Earth. Human activities have significantly impacted water bodies, resulting in widespread degradation, pollution, environmental change, and a scarcity of potable water in parts of the world. Therefore, it is imperative to recognise the importance of water resources and take proactive measures to safeguard them, ensuring their availability for future generations and the sustainability of ecosystems. Ocean and freshwater literacy involves a deep understanding of how human actions affect aquatic environments and how these environments, in turn, impact human life. This concept highlights collective and individual responsibilities towards oceans and freshwater systems and aims to foster stronger emotional connections and drive behavioural changes through formal and informal education.

Scientific data

With the rapidly evolving and compound pressures of environmental change, pollution and overexploitation of water resources, the education system is at risk of being behind the latest scientific understanding. This, in turn, risks generalisation of local pressures in global context (for example, misinterpreting weather as climate), or attitudes of dismissal, apathy, or anxiety either because problems only appear far removed from people's daily lives, or because the environmental problems we collectively face are seen as insurmountable. Scientists and science communicators carry a burden of responsibility to objectively inform the public, but for young audiences, schools need to be as responsive as possible to relate this information to their pupils. Smart learning interfaces are required to facilitate this process, providing distilled but accurate, locally and globally relevant information from scientific models and observations.

Using citizen science methodology

Ocean and humans are inextricably interconnected. The importance of ocean and freshwater literacy can be better understood when placed in the context of citizen science. With ocean and freshwater playing a major role in human lifes, citizen science provides a framework to actively involve the public in scientific research, helping to generate extensive datasets and bridge the gap between scientific understanding and public awareness. Citizen science is a practice of public engagement and collaboration in scientific research, aimed at augmenting scientific knowledge (Ullrich, 2024). It entails the active involvement of citizens to facilitate data monitoring, collection programs, and various research activities (Mandeville *et al.*, 2023). This method enables researchers to gather widespread data through community efforts. Participation in citizen science is typically voluntary and unpaid, fostering profound engagement from community members in scientific pursuits that align with their interests and societal concerns. This multifaceted practice spans a broad spectrum of disciplines, including ecology and environmental science.

In the context of environmental research, local community involvement integrates environmental issues with local, informal, or indigenous knowledge, helping to bridge research gaps. An

increasingly recognized approach, citizen science enhances public education and scientific literacy while fostering collaboration among communities, individuals, and researchers. Given its characteristics, citizen science is a compelling methodology for raising educational awareness about ecological and environmental issues. It plays a crucial role in deepening understanding, fostering environmental stewardship, and promoting active participation in scientific endeavours among students. Through a hands-on approach, citizen science enables educators to enhance learning and engagement, cultivating interest and critical thinking. The application of citizen science techniques offers diverse opportunities for educators to integrate these methods into their lessons through curriculum incorporation, advanced tools, and technology. This deliverable aims to elaborate on these concepts, enabling schools to more effectively incorporate citizen science as a pedagogical approach.

2. Needs of educators

The internet provides a vast array of citizen science resources in multiple languages, catering to diverse audiences. As highlighted in the previous section, videos, research papers, and guidelines for teachers on citizen science already exist, as well as information on designing relevant activities. However it is not clear that these resources are in educator-friendly formats or are shared in platforms where educators are likely to search. ProBleu is developing a repository dedicated to teaching resources to foster ocean and freshwater literacy and support blue schools. This platform, which will be targeted specifically at educators, presents an opportunity to present existing citizen science resources, or develop new resources, in a space targeted specifically at educators.

Teaching resources are currently being generated and collected into a common repository across a key range of topics linked to grand challenges in aquatic ecosystems. These topics include:

- Eutrophication
- Upwelling
- Ocean temperature
- Global circulation
- Ocean currents
- Microplastics
- Weather
- Biodiversity
- Acidification
- Deoxygenation

This repository is specifically designed to address the needs of educators to develop lesson plans and school projects. Figure 1 provides an example of a resource bundle on the topic of eutrophication.

Figure 1: Mock-up of a resource bundle on the Eutrophication topic

In educational citizen science projects, the role of educators is paramount. They play a crucial role in designing citizen science oriented activities as part of the school curriculum and in the process, facilitating effective communication between students and professional researchers (Hecker et. al., 2018). There is a growing recognition within the educational community of the significant benefits that such engagement brings, as it immerses students in authentic research practices. However, to maximise learning outcomes, it is essential that these projects extend beyond the basic tasks of data collection and analysis (Gray et. al., 2012). Furthermore, citizen science frameworks in educational settings should not solely focus on scientific experimentation. Instead of limiting activities to any one category, activities must be collaborative in nature, closely integrating scientists with students. Alongside, projects must be inclusive in nature. Activities designed must acknowledge and value the diverse contributions of all participants, irrespective of their level of expertise. By doing so, these projects can foster a more inclusive and enriching learning environment that benefits both students and the field of citizen science.

2.1. Co-design

Co-design of teaching guidance, resources and the accessible presentation of the catalogue itself are part of the ProBleu approach. Initially, input is sought through surveys followed by co-design focus groups. As educators become content contributors, the catalogue provides support to co-design across schools. The design of sharing, ranking and language support are key considerations. Figure 2 below outlines this co-design timeline, highlighting key elements. The initial version of the platform, developed and populated with teaching resources, is planned for autumn 2024. This will allow time for applicants on the third ProBleu funding call to view the platform and adopt any of the offered teaching resources when writing their project proposal.

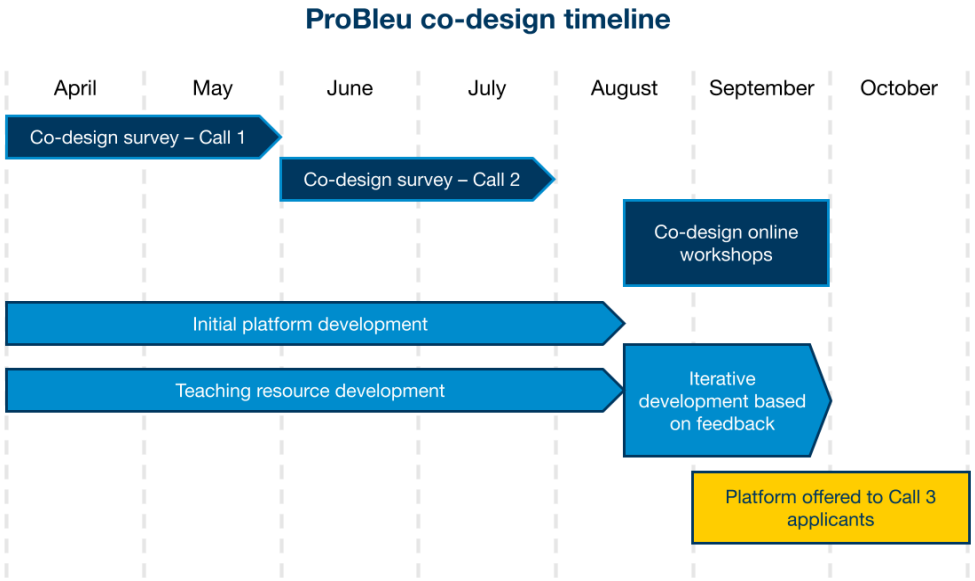

Figure 2: timeline of co-design process for first stages of development of ProBleu teaching resource platform, covering April to October 2024.

2.2. ProBleu teaching resources survey

To inform the development of teaching resources in WP3, it is important to understand educators' needs with regards to resources. To this end, a preliminary co-design survey was prepared and distributed to all applicants to the first ProBleu call. The aim of the survey was to gather teachers' input on how the ProBleu resources could be tailored to their needs. The survey consisted of seven questions: five multiple-choice questions and two which allowed open-text responses. The questions covered teachers' current experience of digital teaching resources, the technological resources available in schools, and their curriculum requirements. An invitation to participate in a future online co-design workshop was also included at the end of the survey. The invitation email and full set of questions from the survey is available in Annex 1. The aims, methods, and handling of data in the study were approved by Earthwatch Europe's ethics process (application code: PB009).

The survey was shared with all teachers who applied to the first call regardless of whether they had been successful in securing funding or not. The survey was emailed to schools in April 2024. In total, the survey was distributed to 69 schools, 27 primary schools and 52 secondary (some applications were from combined primary and secondary schools). 14 schools responded to this first survey (20%). In June 2024, the same survey was sent to all schools who had applied to the second call. In total, the survey was distributed to 76 schools: 42 primary schools and 34 secondary. To date, 27 schools have responded to this second survey (35.5%), as of 16th July 2024. A summary of the results from these two rounds of surveys is given below.

2.3. Results summary and analysis

In total, the survey encompassed 27 responses from educators across Europe. A predominant concern highlighted was the insufficient availability of technological tools. In response to the question "*Are there enough technological tools available for each student to work individually?*", half of the educators indicated that their schools only possessed adequate technological resources for students to work in pairs or small groups. Conversely, 11% of respondents reported a severe shortage of such tools, while 40% stated that their institutions were adequately equipped. Figure 3 portrays the aforementioned statistics in the form of a pie chart.

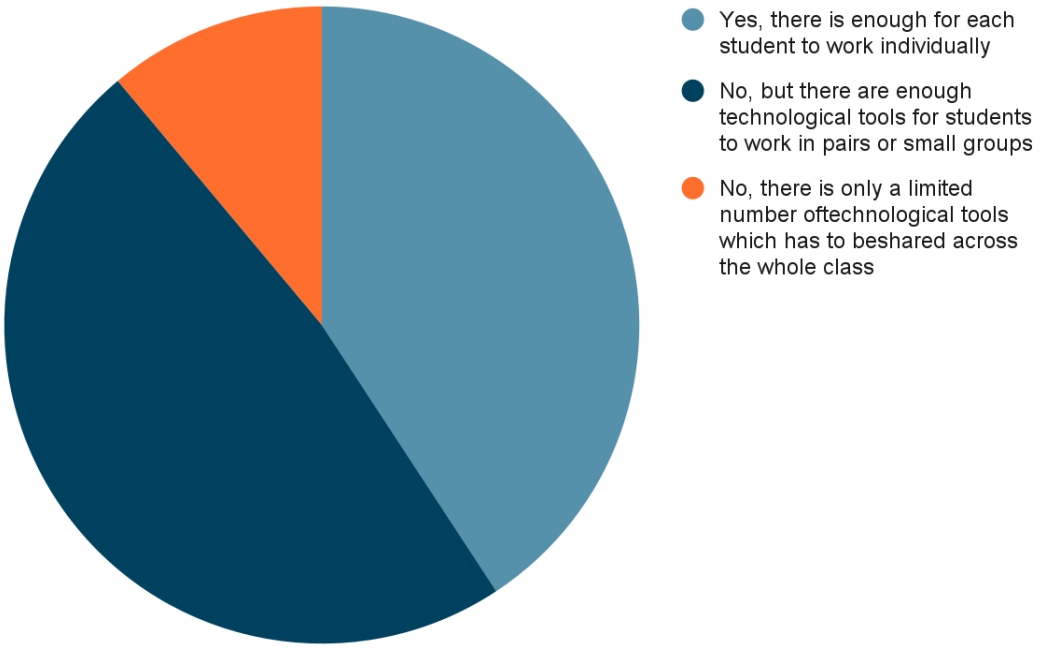

Figure 3: Availability of technological tools

Notably, all but one primary school surveyed reported experiencing either partial or complete deficits in technological equipment. In contrast, among secondary schools, 52% reported sufficient access to technological tools, while the remaining 47% noted partial or complete inadequacies. It is noteworthy that none of the primary schools surveyed reported having complete access to technology. Figure 4 depicts the aforementioned data.

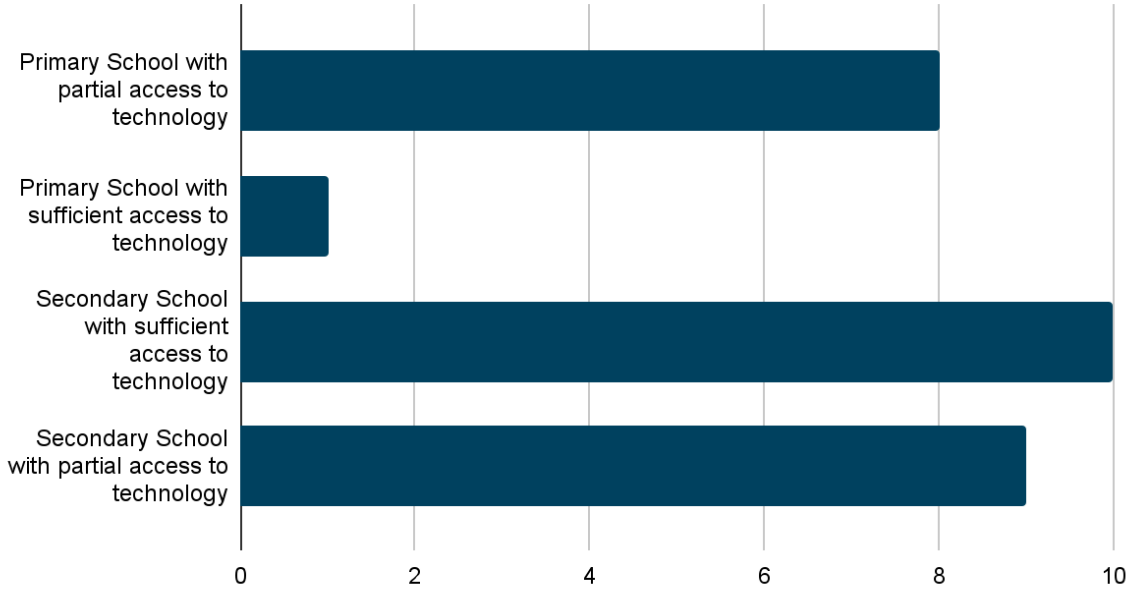

Figure 4: Access to technology amongst European Primary and Secondary schools.

Most of the aforementioned technological tools were in the form of computers, classroom internet access and class projectors. Answers to "*What are the technological tools and equipment available in the classroom settings for facilitating digital teaching and learning?*" of the survey portrays that 25 out of 27 respondents stated to have access to computers, whereas 21 responses stated to have access to projectors in the classroom. The full data set has been depicted in figure 5. The type of technological tool educators have access to directly impacts the online resources accessed by them. Online resources such as editable worksheets and educational games were more popular amongst institutions where students had access to smartphones, tablets or digital textbooks. Similarly, interactive simulations and virtual-reality experiences were more popular in schools where students had access to smartboards and headphones. The full data set can be found in annex 1.

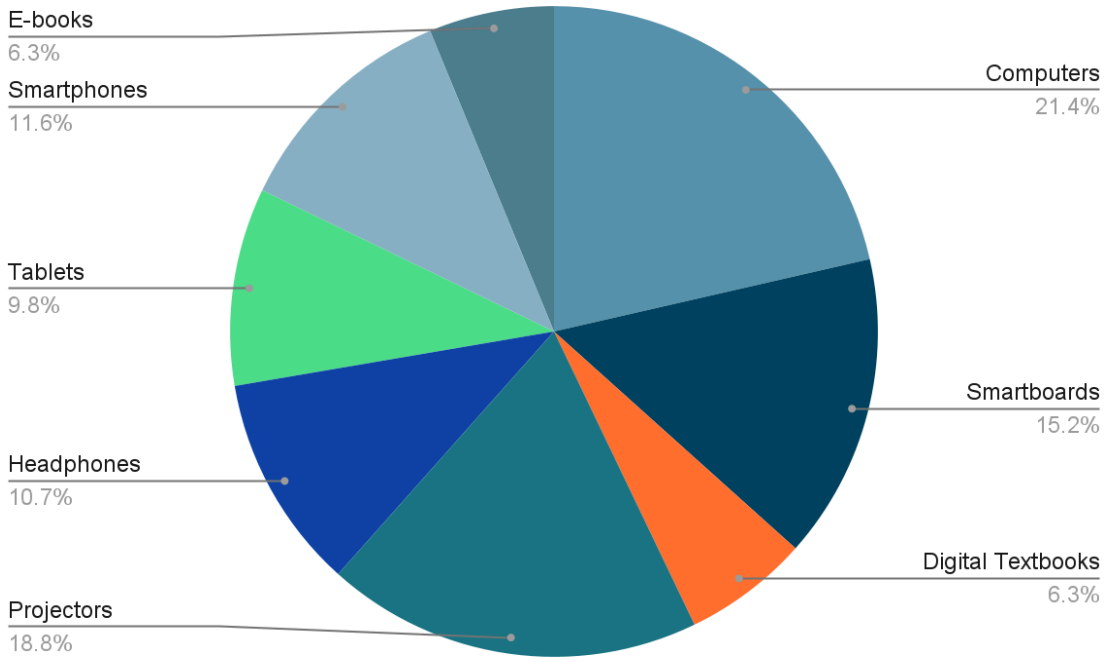

Figure 5: Access to technology amongst schools

Answers to which digital teaching resources on ocean and water literacy interest educators the most revealed that the most effective online resource for teaching students about water literacy was found educational games and videos. 74% of educators citing games and videos as the most common and effective online resource. Figure 6 portrays the full dataset. Research demonstrates that employing interactive, research-driven educational models can substantially boost classroom performance, enhancing the overall efficacy of the educational process (Wienman, 2015). Interactive and gamified approaches ensure that students are not merely passive recipients of information but active participants in their own learning journey, which is crucial for developing critical thinking and problem-solving skills. Literature proves the benefits of using gamification

techniques in education. Such pedagogy supports a positive attitude and behaviour change, fostering collaboration among students (Hays, 2005., Schoech et al., 2013., Schafer et al., 2013).

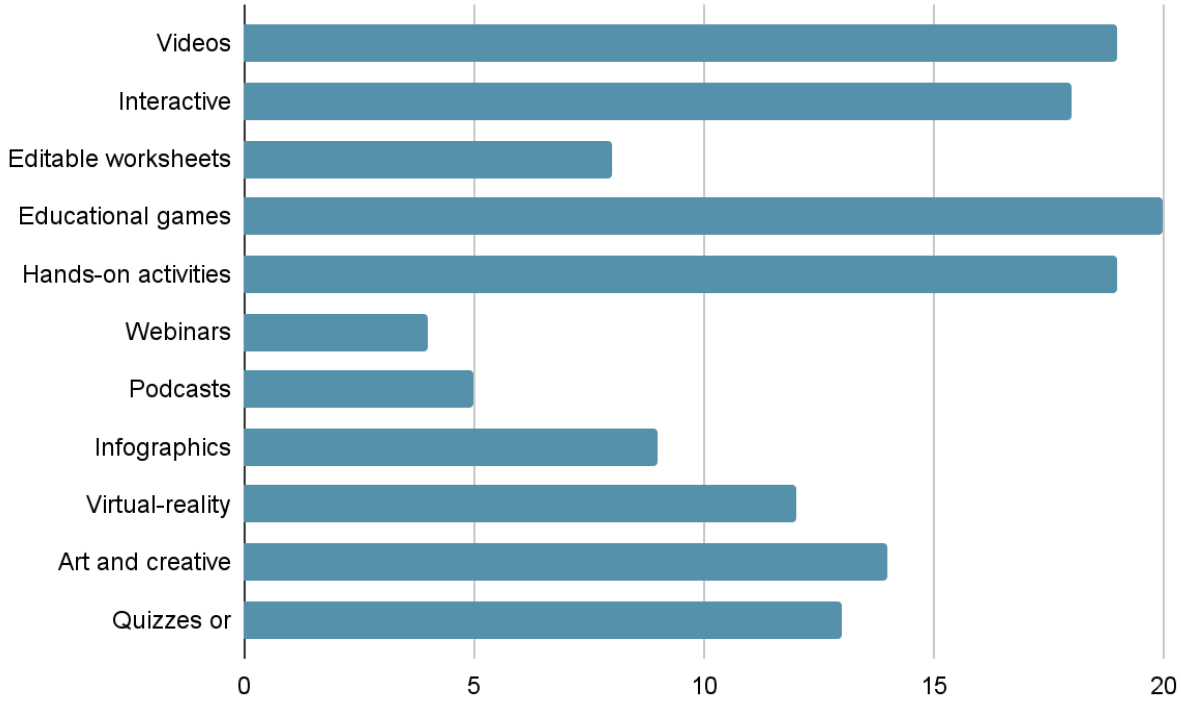

Figure 6: Digital resources most effective in teaching

A full analysis of results from the survey will be completed once the deadline for responses from the second call applicants has passed. These results will be used to inform the design of teaching resources within WP3, including the insights already identified in the analysis above. If needed, a similar survey may be shared with applicants to the third and fourth ProBleu call although the content of the survey will likely be updated to better reflect the progress already made in developing resources.

2.4. Accessibility requirements

Alongside specific content requirements identified in the survey with regard to particular topics and curriculum links, there are several accessibility requirements which are generalisable across most schools. Whilst the co-design survey provides some insight in this regard, it has to be recognised that the pool of respondents is probably biassed toward schools with fewer accessibility needs given that they completed an online survey in English. All respondents must therefore be assumed to have some level of digital literacy and understanding of the English language. To make the ProBleu teaching resource platform truly accessible, consideration therefore must be given to additional accessibility requirements beyond just what is mentioned in the survey.

Language: the platform (and teaching resources hosted within the platform) would ideally be accessible to teachers regardless of their nationality and fluency in a particular language.

Technical skill: there is a wide range of digital literacy among educators and some teachers will lack the technical skills to engage with complex digital applications. The design of the ProBleu platform therefore needs to be accessible to accommodate as many users as possible regardless of their technical skills.

Technical availability: as highlighted in the responses to the survey, some schools have a lack of available technologies and therefore struggle to engage with digital resources. Wherever possible, the ProBleu platform should therefore offer offline options.

Vision & Hearing impairments: considering impairments amongst users is essential. Online material should be made accessible with voice overs, subtexts and other necessary requirements. More importantly, it must be ensured that resources are compatible with common assistive technologies like screen readers, speech-to-text software, and alternative input devices.

Learning disabilities: to ensure inclusivity for individuals with learning disabilities, resources must be clear, grouped in small, manageable chunks with adjustable text size, font, and background colour. Some materials could also be tailor made for those with learning disabilities.

2.5. Co-design workshops

The next step in the co-design process will be a series of online workshops with educators, to gain deeper insight into their requirements for lesson planning and to get specific feedback on the resources which have already been developed. PML will lead these workshops. Participants will be recruited from the teachers who already volunteered to take part, as well as newly funded ProBleu schools. 21 respondents from the teaching resource survey have already expressed an interest in taking part in these workshops. Working in small groups, both co-design and sharing of ideas between educators will be facilitated.

These workshops will take place in September 2024, when an initial version of the platform is ready for testing and feedback. Participants for the workshop will be contacted in advance arranged into groups based on language considerations (with a corresponding ProBleu facilitator wherever possible). A focus group might also be formed with schools who have limited access to technology to understand their specific requirements into how the platform can be adapted to suit their needs. Outcomes from these workshops will be reported in deliverable report D3.2.

3. Technical design

The ProBleu catalogue is designed to facilitate the sharing of content linked to water literacy subjects. Its primary functions are to allow educators to upload content, search for materials, create resource bundles in preparation of lesson plans, and download this content to their devices. It is intended that these materials will be adapted by educators for the specific needs for their classroom. Finally, sharing resource bundles back in modified form should be supported to aid the efforts of other educators, and result in a gradually expanding catalogue.

Technical Architecture

The Django web framework handles all aspects of the user interface and back-end functionality. It is connected to a PostGRES database which stores the content. Nginx is used as the web server to host the application. Applications which support the uploading of user generated content are ImageMagick and LibreOffice. Automated language translations are made via the Microsoft Azure AI Translator. Redis and Celery are two applications that support the translations of slides into multiple languages.

Top level design

Landing Page: Concisely describe what the ProBleu catalogue is intended for and link users to (a) pages describing how to get started or (b) commonly used procedures.
Navigation Bar: Menu bar located across the top of the page which allows for easy navigation across the site.
User Page: User specific area (via registration/login) which shows what content they have uploaded and bundles they have created.
Bundles Page: Page which allows all users to browse the bundles that have already been created.
Virtual Journeys Page: Enhanced educational material that offers more interactive learning from scientists. This material may be integrated into resource bundle structures and also exists on its own.
Topics Page: Group bundles and content into one of the [8] major topics of water literacy
Contents Page: Shows all of the material that has been uploaded to the catalogue. This will be grouped into the different types of content.

The content that will be supported in the catalogue will be:

1. Slides
2. Videos
3. Simulations
4. Documents (Word/PDF)

5. Links to external resources

Cookies: Enhances user experience. For example, users can be identified as new starters, their language preferences stored. However, users should be allowed to opt-out of using cookies.

User Stories

The catalogue is designed to support the following user stories:
As an educator, new to the catalogue, I want to learn how to use the catalogue so that I can use it independently:

1. Cookies to be used to identify new users and their language preference.
2. New users are greeted to the catalogue with an overview page. This page should include having a virtual tour which would show users how to navigate and use the site. Contents of this virtual tour will be based on the user stories highlighted in this section.
3. Overview page should have a "Start Here" link to it so that users can always access this information.
4. New users will be shown how to switch the catalogue into different languages.
5. Tutorials page will display embedded videos. Each one of these bitesize videos will describe in detail the processes described in user stories highlighted in this section.

As an educator, I would like to search through the catalogue to identify what material I could use for my lessons so that I can build my own resource bundles:

1. Guests and registered users can browse content.
2. Browsing the content will be facilitated by the ability to:
    a. Search for text. This text will be used to search through the contents based on:
        i. Title
        ii. Description
        iii. Keywords
        iv. Model Specific Categories. e.g. Transcript (Videos)
        v. Authors
    b. Filter by:
        i. Topics - All content is tagged with one of the [currently eight] major topics of water literacy. These major topics have their own areas of the catalogue that only displays the content that relates to these areas.
        ii. Original Language
        iii. Rating
        iv. Age appropriateness
    c. Sort by:
        i. Popularity - How many times the contents has been used in a bundle
        ii. Updated - The last time the content was updated
        iii. Newest - The latest content to be uploaded to the catalogue
        iv. Rating - Ratings based on registered users

3. Registered users can create an empty resource bundle to be appended with content. Guest users are encouraged to create account
4. Registered users are able to select content of interest and add/remove content to their bundles.
5. Registered users should be able to:
    a. Rate content - Authors will be prevented from rating their own material
    b. Flag content for concern - Flagged content may be removed from the catalogue pending a review from moderators.
6. Bundles to be downloadable to the user. Content that is not compatible with a slide deck will be attached as part of a .zip file.

As an educator, I would like to adapt existing bundles which look of interest to me to reduce the time it takes to create bundles:

1. Registered users can clone existing bundles. Guest users will be encouraged to create an account
2. Users will then be able to add content to their newly cloned bundle.
3. Users can edit the name, description and ordering
4. References to the original content will be continue regardless of how many times the original content is cloned

As an educator, I would like to upload my own materials to the catalogue so that others can re-use my materials and I can see where these have been used:

1. Registered users can upload contents to the catalogue. They will be able to input some metadata / tags to the contents including:
    a. Title
    b. Topics the content relates to
    c. Appropriate ages for the content
    d. Keywords that relate to the content
    e. Content Specific Categories e.g. Transcript (Videos)
2. Guidance for Uploads / Content will feature on the catalogue providing advice for users on best practises for using the catalogue. Users will need to confirm:
    a. Ownership
    b. Licensing - Users will be able to acknowledge any content they have uploaded that relates to other upload process
    c. Code of Conduct read and understood

Accessibility

The catalogue design should provide accessibility to a wide audience. Specific considerations are detailed as follows:
Language - Educators will require the catalogue to be understandable in their own language

- Static parts of the catalogue are translated into all of the supported languages using automated language translation.
- Where possible, content uploaded to the catalogue is translated into all of the supported languages.
- The catalogue will offer the option for users to improve translations

Technical skill - Educators who have low technical skills require a catalogue that is easy to use.

- Catalogue browsing is as simple as possible. The site layout mimics popular website design in terms of top level navigation and searching, and does not introduce specific terminology. Text is kept concise.
- Details of the layout include:
    - A single menu bar located at the top of the screen that is replicated on every page.
    - Embedded hyperlinks for contents to seamlessly move around the catalogue.
    - A search bar to allow users to focus their interests on specific areas.
    - Intuitive icons for searching, downloading, uploading, finding help and user details.
    - Tutorial videos linked from the landing page demonstrate the most popular use cases.

Technical availability - Educators who are working in schools which do not have a reliable internet connection must be able to use the material offline.

- The catalogue is designed so that educators build their bundles online and then download them to their devices for offline use. This would be done before any lesson is conducted in the classroom.
- Where possible, content uploaded to the catalogue will be replicated for offline use. Exceptions to this will be videos that are hosted on third party platforms. If educators have premium accounts with these platforms they will be able to download the videos for offline use.
- Educators will be able to filter for content that is available to be downloaded for offline use.

Visual impairments - Educators who have visual impairments must be able to adapt the site so they can use it:

- Sufficient contrast across the catalogue to be used
- The catalogue will limit the colours used across its design
- Educators to be able to customise font size
- Hyperlinks to have descriptive labels
- Keyboard navigation across the catalogue to be enabled and simple
- Images to include alt text
- Pages to be clearly labelled with titles

Auditory impairments - Educators who have auditory impairments must be able to adapt the site so they can use it

- Educators will be encouraged to add close captioning to videos uploading to hosting sites. This will be added to the Guidance for Uploads document hosted by the catalogue)
- Educators will be encouraged to upload transcripts for any video content. This will be one of the fields that will be translated into the support languages

Object Relationships

The ProBleu catalogue is built up of content uploaded from educators, which form the fundamental building blocks that relationships across the catalogue are constructed from. Example content and their associated fields are demonstrated in Figure 7. The ProBleu catalogue will support the following content:

- Slides
- Videos
- Simulations
- Documents
- Activities
- External Resources

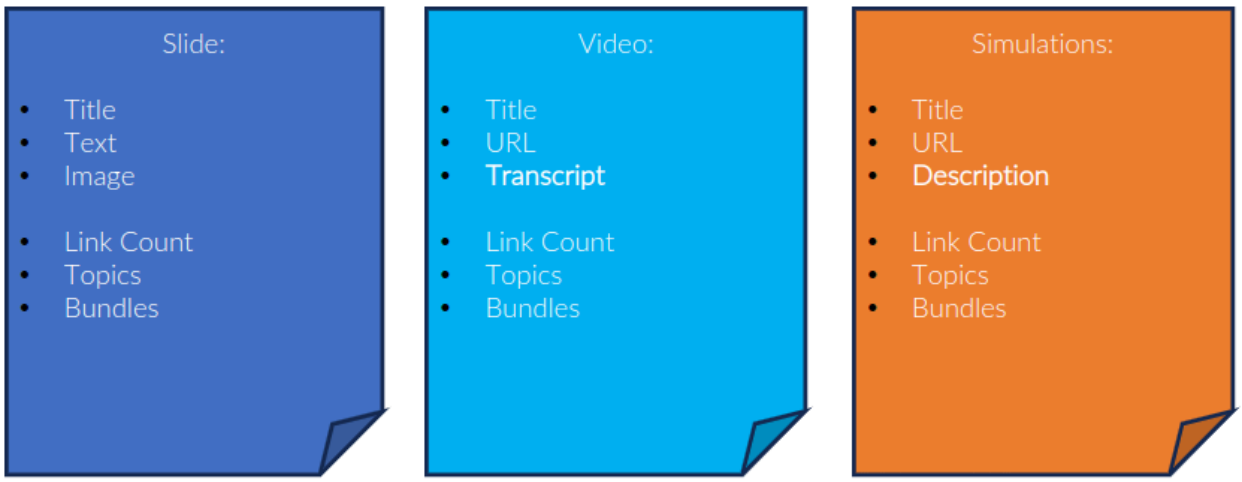

Figure 7: Content building blocks with example fields provided

Content that is uploaded to the catalogue is stored in a PostGRES database. When users access the content it is visualised to their screen in a similar way to that depicted in Figure 8.

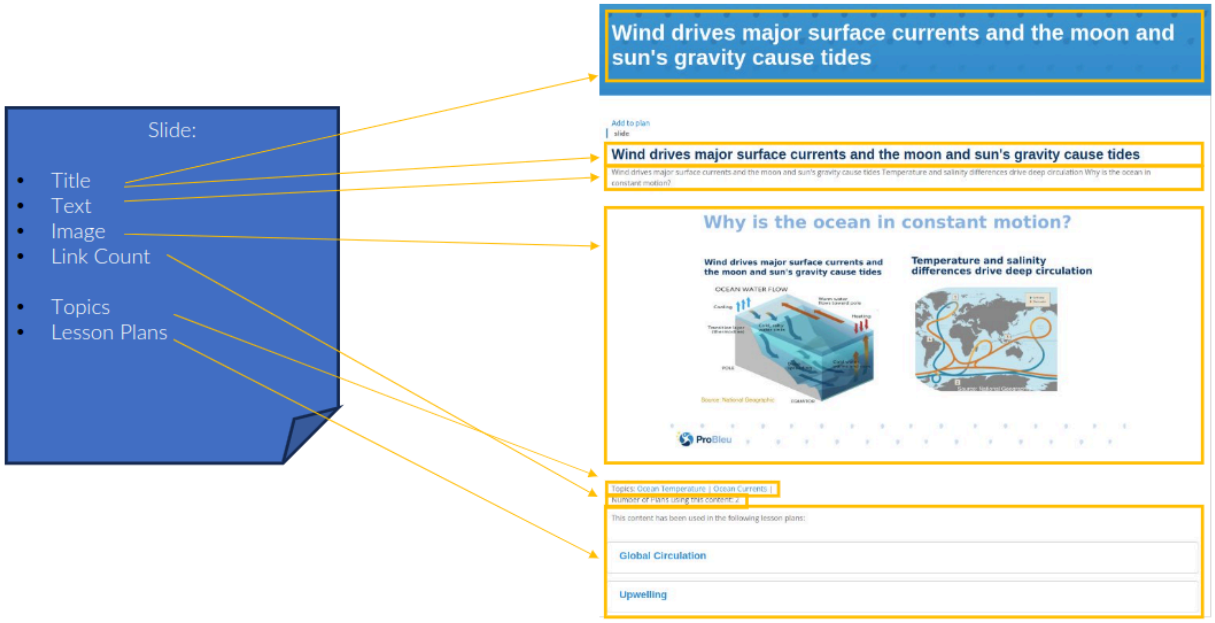

Figure 8: Relationship between content block and how it is visualised to the user via the web browser

Resource bundles are collections of content created by educators to suit the needs of their students. Viewing a resource bundle on screen shows all of the content that has been linked to that bundle. This relationship is depicted in Figure 9. These resource bundles are downloadable into a slide format for further customisation on the educator's local machines.

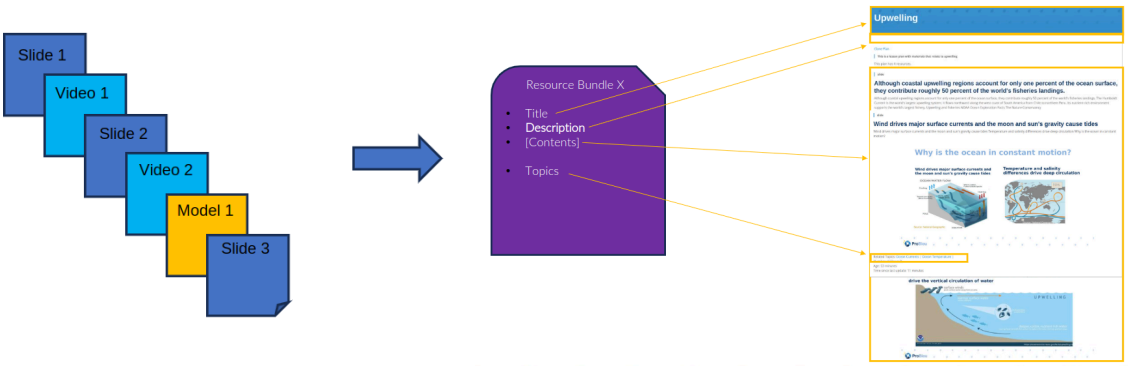

Figure 9: Relationship between contents and bundles and how they are visualised to the user via the web browser

Topics are one of the ways that content and resource bundles are grouped together. They cover the main water literacy themes. Content / Bundles can link to more than one topic and topics can have multiple content / bundles associated with them. This is depicted in Figure 10.

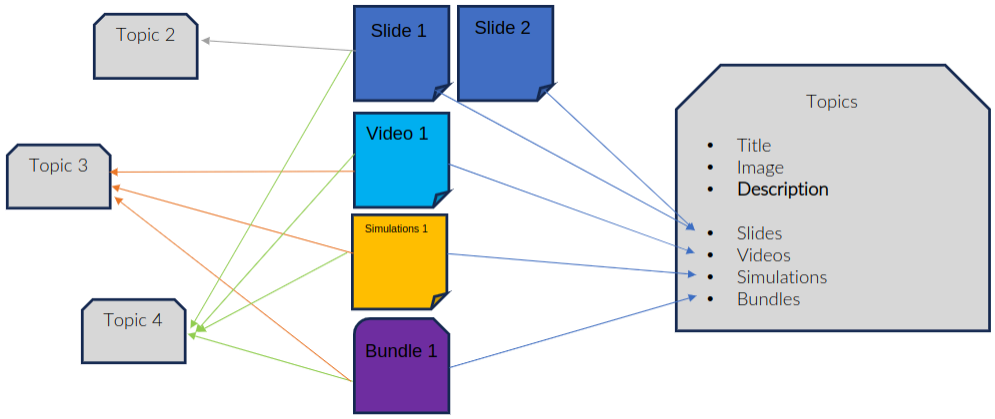

Figure 10: Relationship between contents, bundles and topics

Users can then easily browse content / bundles that relate to their subject of interest by navigating to the appropriate topic page. The content is grouped into different objects like Slides, Videos etc for ease of navigation / selection. This is shown in Figure 11

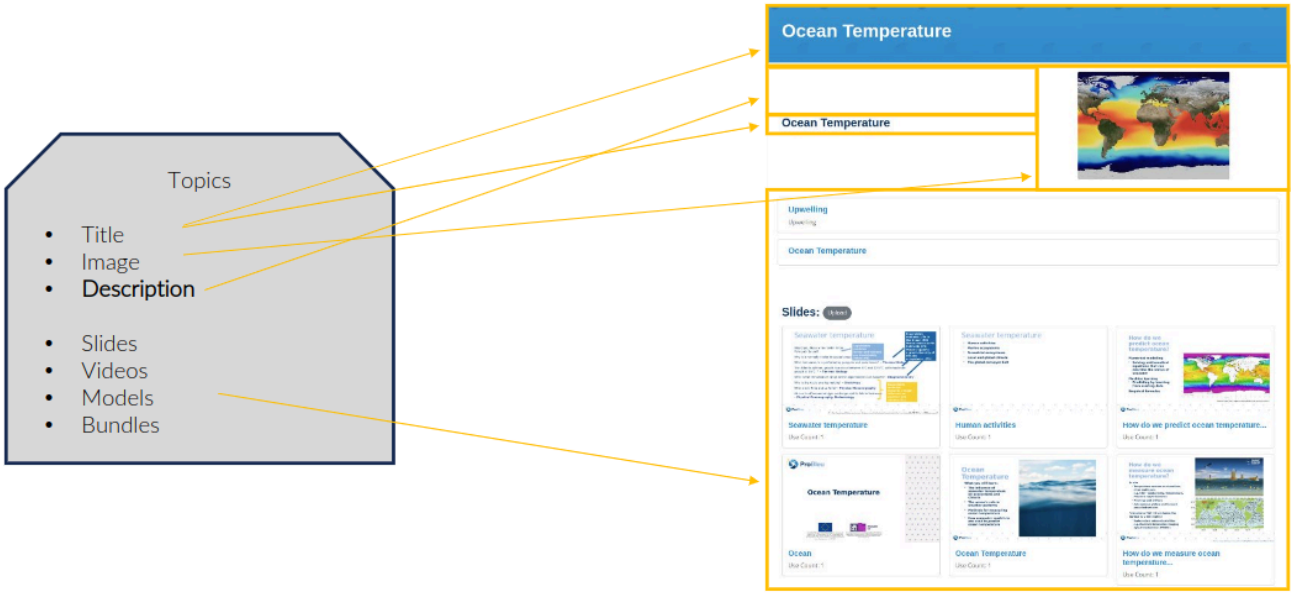

Figure 11: Visualisation of topic-specific content

Virtual journeys

Virtual journeys are, as far as platform design is concerned, a specific type of resource bundle. They feature a collection of content from across the catalogue but they include suggested learning elements and related materials alongside staged introduction to educational material, spotlighting scientists in the process of collecting or analysing research materials. An example of this is a video showing a tour of a research vessel and the activities carried out onboard.

4. Citizen science tools for data collection

ProBleu aims to support educators to adopt citizen-science tools for education on oceans and freshwater. An important step in this regard is to ensure that citizen science data-collection tools are easily findable and accessible for the school context. To a certain extent, this is already the case as a number of existing networks, platforms and projects have catalogued marine and freshwater citizen science projects. For instance, several citizen science networks and online platforms host catalogues of citizen science projects and data collection tools (Table 1).

Table 1. ***Platforms and online catalogues of marine and freshwater citizen science tools***

Name of resource site (and URL)		Description
General citizen science platforms		
1	EU Citizen Science https://eu-citizen.science/	This platform consolidates various resources on citizen science including a catalogue of citizen science projects. The catalogue can be filtered by topic including an "Ocean, Water, Marine and Terrestrial" topic. 39 of the 336 projects catalogued on the platform are connected to this water-specific topic (as of July 2024).
2	SciStarter https://scistarter.org	SciStarter is a global online citizen science hub which offers a comprehensive suite of resources including a project finder tool. As with EU-Citizen.Science, projects can be filtered by topic including an "Ocean, Water, Marine and Terrestrial" topic. 305 of the 1408 projects catalogued on the platform are connected to this water-specific topic (as of July 2024). Projects can also be filtered by the age group of participants, allowing educators to find projects which are appropriate for the age they teach.
3	Zooniverse https://www.zooniverse.org	Zooniverse is a citizen science web portal which hosts online citizen science projects across a range of topics. Because participation is online, volunteers can engage with projects studying remote or difficult to access locations. This is of particular interest in the context of ocean literacy as, for example, it allows participants to take part in projects studying the deep sea. Projects can be filtered by topic, but there are no marine- or freshwater- specific topics. 16 of the 83 active projects catalogued on the platform are connected to ocean or freshwater themes (as of July 2024).
Marine- and freshwater-specific platforms		

4	WaveLinks https://wavelinks.eu/	A marine research and innovation platform developed in collaboration between three Horizon Europe projects: PREP4BLUE, BlueMissionBANOS and BlueMissionAA. The platform also includes a catalogue of European marine and freshwater citizen science projects. This is the most comprehensive public catalogue of its kind with 967 separate projects included (as of July 2024).
5	Iliad https://ocean-twin.eu/marketplace/product/cs-catalogue	A catalogue of marine-specific citizen science projects based in European seas. The catalogue identified 105 relevant projects which were active in January 2023. An extended version of this catalogue is planned, building also on the work of WaveLinks.

Outside of the EU there are many other platforms which contain similar catalogues of citizen science projects e.g. CitSci.org and Atlas of Living Australia [https://www.ala.org.au/]. In addition to these platforms, a number of academic reviews have also identified marine and freshwater citizen science projects. An overview of these review papers and reports is given in Table 2 below.

Table 2. ***Academic papers and reports containing lists of marine and freshwater citizen science projects and tools***

Paper or report title, author, date and URL		Description
Marine citizen science tools		
1	Citizen Scientists and Marine Research: Volunteer Participants, Their Contributions, and Projection for the Future (Thiel et al. 2014). http://dx.doi.org/10.1201/b17143-6	A systematic literature review of marine citizen science studies which identified 227 projects published before 2014. Projects are classified by their study subject, country, habitat and objective.
2	Marine Citizen Science: Recent Developments and Future Recommendations (Sandahl and Tøttrup, 2020). https://doi.org/10.5334/cstp.270	This paper builds on the review by Thiel et al. using the same methodology to identify a further 185 marine citizen science studies published between 2014-2018.
3	MARCSI (in press) (Wehn et al).	This paper (in press) builds on and combines previous review papers and citizen science catalogues. In total, the paper identifies over 1200 marine citizen science projects from around the world.
Freshwater citizen science tools		

4	Citizen science projects in freshwater monitoring. From individual design to clusters? (Kirschke et al. 2022) https://doi.org/10.1016/j.jenvman.2022.114714	This study provides a systematic comparative analysis of the design of 85 citizen science projects in the field of freshwater monitoring.
5	Applied citizen science in freshwater research (Metcalfe et al. 2022) https://doi.org/10.1002/wat2.1578	This discusses how citizen science is being applied in freshwater research, providing numerous examples of projects addressing this topic.
6	Goals and approaches in the use of citizen science for exploring plastic pollution in freshwater ecosystems: A review (Cook et al. 2021)	This review explores the status of freshwater citizen science focused on plastic pollution. The environmental and geographic extent of the research was considered, along with research scope, methods, involvement of citizen science, and data quality.

Each of these platforms and reviews have different focuses and target audiences but, collectively, they represent a comprehensive overview of marine and freshwater citizen science projects. In theory, then, it should be easy for educators to find relevant citizen science and data collection tools to use within their blue school projects. However, whilst there are many sources available to find citizen science tools, very few of these catalogues are specifically targeted at educators or tailored to their needs. Whilst there are not education-specific repositories of citizen science projects, many individual citizen science projects and resources have been adapted for educators or designed with education in mind. Table 3 provides a collection of notable examples, including online toolkits and case studies focused on the development of student-centred projects within citizen science.

Table 3. ***Online resources for training educators on Citizen Science***

Name of resource (and URL)		**Description**
Citizen science education resources		
1	Citizen Science Education (ECSA working group) https://sites.google.com/view/citizen-science-education/home	A website for the ECSA working group on education which collects relevant resources including a book chapter on education best practices (Harlin et al. 2018).
2	SciStarter https://scistarter.org/Education	SciStarter offers a comprehensive suite of resources regarding a variety of topics on citizen science. Education resources and projects are adapted to different pupil ages and school stages.
3	California Academy of Sciences	The site provides a toolkit designed to help educators

	https://www.calacademy.org/educators/citizen-science-toolkit	integrate citizen science projects into classroom teaching including resources such as lesson plans, worksheets and examples of citizen science activities.
Citizen science projects adapted to educators		
4	GLOBE https://www.globe.gov/	GLOBE is an international science and education programme which hosts a range of citizen science projects specifically targeted at schools. The "hydrosphere" is included as one of four priority areas with citizen science projects studying water pH, temperature, transparency, conductivity, dissolved oxygen and nutrient pollution.
5	Plastic Pirates – Go Europe! https://www.plastic-pirates.eu/en	Plastic Pirates is a citizen science campaign specifically targeted at school classes and youth groups which aims to collect and document plastic samples from streams and rivers across Europe.
6	FreshWater Watch https://www.freshwaterwatch.org	FreshWater Watch is a global citizen science programme monitoring the health of freshwater ecosystems. Specific resources have been produced to help adapt the project to educators and to make links to other elements of classroom learning.
Accessible resources and introductions to citizen science (not education specific)		
7	EU Citizen Science https://eu-citizen.science/resources	This platform consolidates various resources on citizen science. The platform contains links to resources in various languages and various aspects of citizen science.
8	Moodle course https://moodle-dev.ibercivis.es/course/index.php	This platform provides introductory courses to citizen science through reading materials and videos.
9	Life Watch Italy https://citizenscience.lifewatchitaly.eu/training-room/	This site offers training materials created for current citizen science projects and initiatives, aiming to share best practices and enhance knowledge in the field.
10	Biodiversa+ https://www.biodiversa.eu/research-funding/guides-capacity-building/citizen-science-toolkit/	The Biodiversa Citizen Science Toolkit aims to assist professionals in biodiversity and environmental sciences in engaging citizens in their research projects. It offers examples of Citizen Science projects, and includes testimonies from researchers.
11	Una Europa https://www.una-europa.eu/knowledge-hub/toolkits/citizen-scie	The Una Europa Citizen Science Toolkit supports netizens in initiating and engaging in citizen science projects. It provides practical guidance through

	nce-toolkit#content	interviews with experts, summaries, and top tips, covering aspects from project design to sustainability. The toolkit aims to bridge the gap between academia and the public, enhancing the impact of research across various disciplines, including cultural heritage.
12	CitieS-Health Toolkit https://citizensciencetoolkit.eu/	The Citizen Science Toolkit helps to engage in citizen science projects through four phases: Identification, Co-design, Deployment, and Action. It includes tools and video tutorials for each phase, allowing users to download and adapt resources for their projects.
13	citizenscience.gov https://www.citizenscience.gov/toolkit/#	The Federal Crowdsourcing and Citizen Science Toolkit provides a comprehensive guide to plan, design, and execute crowdsourcing and citizen science projects. It includes five key process steps, practical tips, case studies, and a resource library.
14	Eutopia https://eutopia-university.eu/english-version/contact-us/zenodo/a-eutopia-citizen-science-starter-kit	The EUTOPIA Citizen Science Starter Kit is designed to support researchers new to citizen science. The kit helps researchers determine if citizen science is suitable for their projects.
15	UK Center of ecology and hydrology https://www.ceh.ac.uk/sites/default/files/sepa_choosingandusingcitizenscience_interactive_4web_final_amended-blue1.pdf	This PDF is a guide to when and how to use citizen science to monitor biodiversity and the environment

Overall, it is clear that a wide range of freshwater and marine citizen science tools are available for educators to use and these are discoverable through a number of online platforms and repositories. However, fewer resources are specifically tailored to the education context and it is not always possible to filter resources based on their suitability for teaching. To understand whether additional resources are needed or how the existing resources can be better catalogued, it is first important to understand the requirements of educators and if there are barriers which prevent them from accessing and using what already exists- as analysed in section 2 of this deliverable. D3.2 aims to build on the information provided in this deliverable to provide recommendations to educators regarding how to design a perfect citizen science project around the topics of ocean and freshwater literacy.

5. Next Steps

As highlighted throughout this document, and as a core concept of the ProBleu methodology, a user-centred approach is being adopted to ensure the needs of educators are put at the forefront of design decisions. This includes surveying ProBleu applicants to discover their needs and concerns regarding resources to improve water literacy, and dedicated, co-design workshops to ensure the ProBleu platform and associated content are relevant and useful to educators, and that their voices are heard as part of the design process. It is important to note that this user-centred approach is an iterative process, with feedback regarding the platform, resources and citizen science tools sought from educators throughout the remainder of the project, to ensure that all Probleu outputs targeted at educators are constantly reviewed and updated accordingly.

The following key milestones have been identified for the further implementation of educational support through digital and practical teaching resources:

Key milestones:

- **September 2024:** Led by Earthwatch, teaching resources directly linked to citizen science methodologies for water literacy will be developed and made available on the platform.
- **February 2025:** projects from the first ProBleu funding call are invited to share their resources on the ProBleu platform (with support where necessary), and to become registered users.
- **March 2025:** Shared resources are checked and available for the final round of applicants (funding call 4).
- Projects receiving funding from calls 2 (April 2024), 3 (October 2024) and 4 (April 2025) will similarly be invited to share their materials on the platform.

Key to the success of the platform will be its dissemination to relevant target groups and end users. To this end, European SchoolNet, as contracted by the ProBleu project, will advertise the platform to their comprehensive teacher contact list. Furthermore, the platform will be shared through relevant associated networks, such as the ECS platform [https://eu-citizen.science/], and specifically the ECS network of educators mailing list where citizen science resources specifically aimed at education are shared and discussed. The aim of this process is to create a two-way communication channel, where the platform and its resources are shared, whilst simultaneously gathering feedback and opinion from relevant end-users.

Considering the sustainability of the platform beyond the duration of ProBleu, the consortium is committed to maintaining the platform for at least seven years. Therefore, the platform will be designed and developed in a way that can be containerised, allowing it to be ported easily to any potential server.

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Annex 1. ProBleu teaching resource survey

Invitations to take part in the ProBleu teaching resource survey were sent via email to all applicants to the first and second ProBleu funding calls using the template below:

Subject: ProBleu teaching resource survey

Thank you for your interest in the ProBleu project, which aims to increase water and ocean literacy in school children. We appreciate the time and effort you put into your application. We are still in the middle of evaluating all the applications and will share the result with you as soon as possible.

In the meantime, we would like to invite you to participate in a survey to help us develop teaching resources.This survey has been shared with all teachers who have applied for funding, regardless of whether they will receive it or not. Your response (or lack of it) to this survey does not influence the outcome of your funding application.

ProBleu is building a platform to share teaching resources between schools, open to all educators, regardless of whether they participate in a ProBleu school project. We believe that digital teaching resources can enhance learning experiences, but we also recognise the importance of making them user-friendly and relevant to your specific needs. To better understand how these resources can be tailored to your needs and integrated into your lessons, we're asking teachers to take part in our co-design survey. The survey will take around five minutes to complete, and you can access it at https://forms.gle/r2wsg6D8TqkSrGk47

Your perspective is important to us, and we value your honest feedback. This survey has been shared with all teachers who have applied for funding. We hope you will take the time to complete the survey and help us create resources that engage your students and improve the teaching experience.

The ProBleu teaching resource survey is hosted in a Google Form which has been used since April 2024 [URL to the form: https://forms.gle/r2wsg6D8TqkSrGk47]. The survey has been copied below (accessed June 2024). Questions with an asterisk (*) were compulsory questions.

ProBleu teaching resource survey

Section 1

Thank you for your interest in the ProBleu project which aims to increase water and ocean literacy in schoolchildren. ProBleu is building a platform to share teaching resources between

schools, open to all educators, regardless of whether they participate in a ProBleu school project.

To better understand how these resources we can offer can be tailored to your needs and integrated into your lessons, we politely ask you to participate in a co-design survey.

We believe that digital teaching resources have great potential to enhance learning experiences, but we also recognise the importance of making them user-friendly and relevant to your specific needs.

By sharing your honest feedback, you can help us create resources that enable efficient lesson planning, engage your students and improve the teaching experience.

Your perspective is important to us. This survey has been shared with all teachers who have applied for funding, regardless of whether they have been successful or not. Our goal is to explore the interests and requirements around digital teaching resources (including your previous experience with resources). Below are a few questions that can help us understand your needs better.

By taking part in this survey you give consent for the ProBleu consortium to analyse the answers you have provided and use them to improve the teaching resources they are producing and to write project deliverables.

What school level are you teaching at?*

- Primary
- Secondary
- 3rd to 9th grades + secondary vocational course
- Anatolian high school
- primary and secondary
- Other:

Which of the following digital teaching resources on ocean and water literacy would be of interest to your school (tick all that apply):

- ☐ Data that students can analyse to explore environmental topics, such as local sea-temperature predictions based on global climate models
- ☐ Interactive graphs that empower students to discover, for instance, the link between nutrient pollution, algal blooms, and declining water quality in aquatic environments
- ☐ Interactive maps that empower students to investigate, for instance, the spread of invasive species in aquatic environments, analysing both historical data and future projections
- ☐ Tools that help students understand the relationships among pressures (excessive fertiliser use), impacts (algal blooms), and solutions (reduced nutrient runoff) on water quality

- ☐ Virtual ocean journeys: following the day-to-day operations of scientists on a research vessel (taking students on a virtual trip with marine scientists working in the field)
- ☐ Experiments to assess the environment, for example protocols to collect plastics, or take measurements of nutrients in rivers
- ☐ Simulations and models of ocean and water processes, for example simulating the growth of algae in response to wastewater nutrient enrichment
- ☐ Videos with explanations of various ocean and water concepts.
- ☐ Images (e.g. aquatic plants, animals, laboratory experiments, scientists at work etc)
- ☐ wet and dry labs experiment protocols
- ☐ Others :

What are the technological tools and equipment available in the classroom settings for facilitating digital teaching and learning?

- ☐ Computers
- ☐ Smartboards
- ☐ Digital Textbooks
- ☐ Projectors
- ☐ Headphones
- ☐ Tablets
- ☐ Smartphones
- ☐ E-books
- ☐ Internet connectivity in the classroom
- ☐ university class laboratory
- ☐ Others :

Are there enough technological tools available for each student to work individually?

- Yes, there is enough for each student to work individually e.g. each student has a computer or tablet
- No, but there are enough technological tools for students to work in pairs or small groups

- No, there is only a limited number of technological tools which has to be shared across the whole class e.g. only one computer for the whole class

What types of digital/online resources do you find most effective in teaching ocean and water topics?

- ☐ Videos
- ☐ Interactive simulations
- ☐ Editable worksheets
- ☐ Educational games
- ☐ Hands-on activities
- ☐ Webinars
- ☐ Podcasts
- ☐ Infographics
- ☐ Discussion prompts
- ☐ Augmented-reality or virtual-reality experiences
- ☐ Websites
- ☐ Art and creative projects
- ☐ Quizzes or questionnaires
- ☐ Others :

Which specific curriculum topics do you need the resources to align with?

Your answer

Which online resources have you used to teach ocean and water topics? (Include website links if possible). Please also describe what you like or dislike about these resources in terms of both content offered and technical functionality.(Skip question if not applicable)

Your answer

In addition to understanding what tools are useful to you, we would also like to understand how you would use them. We would like to talk to small groups of teachers to discuss, during a 30-minute video call, how we should present our online interfaces so that you would use them in future. Would you be happy to be contacted about joining one of these focus groups?*

- Yes (Go to section 2 - Participation in focus group)

- No

Section 2 - Participation in focus groups

These focus groups are part of the activities within the ProBleu project [https://probleu.school/]. Participation is voluntary and involves taking part in a 30-minute online group discussion. Your comments will help us to develop and adapt digital teaching resources to improve ocean and water literacy. Any data you provide will be anonymised. If you change your mind at a later date, you can withdraw from the focus group at any time and do not have to give reasons why you no longer want to take part. Your personal details will not be connected to your responses to the first section of this survey.

What is your name?*

Your answer

What is your email address?*

Your answer

What is your school name?*

Your answer