

Toxic Heritage in the Oceans: Story Writing on Marine Plastic Litter in the Pacific

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Abstract:

Plastics are persistent materials embodying consumer culture of the twentieth and twenty-first centuries. Their overwhelming presence as waste in most environments transforms them into a global threat and a toxic heritage permeating all spheres of people's daily lives. Addressing the issue of plastic pollution as a toxic heritage can seem an imposing and impossible task. Looking at marine plastic litter as artefacts to re-construct narratives of their itineraries is presented as an alternative to discussing plastic pollution in its widest sense. This contribution presents story-writing activities in the Pacific region as contemporary archaeological interventions focusing on plastic as a toxic heritage. It summarises the results of two case studies, along the East Pacific coast and in Galapagos, contrasts them, and offers recommendations for adopting the same approach elsewhere. These initiatives can act as an efficient engagement tool on the topic of marine plastic litter with positive effects on the participants. We argue that the best way to engage with toxic heritage may be to look at it closely and interact with it directly, as archaeological material.

Plastics are one of the most representative objects of the Anthropocene, leading some scholars to argue for the use of the term Plastic Age to label the contemporary era (Mytum and Meek, 2020; Porta, 2021). Plastics permeate our environments and bodies in multiple ways (Ragusa *et al.*, 2021; Jenner *et al.*, 2022), sometimes contributing to a generalised feeling of ecological anxiety (Smith and Brisman, 2021). As Wollentz *et al.* (2020) indicate, toxic heritage is not necessarily toxic because of its content; it is also its management and the narratives developed around it that may transform it into toxic heritage. In the case of plastics, their nature could be qualified as toxic, ever-lasting synthetic polymers to which up to 10,000 chemical substances can be added in production (Wiesinger, Wang, and Hellweg, 2021). But it is also the high levels of plastic waste mismanagement that contribute to its disturbing yet overwhelming presence.

This contribution offers insights into the potential narratives that can be created about marine plastic litter (MPL), reinforcing its consideration as toxic heritage already argued by Schofield and Pocock in the accompanying volume on Toxic Heritage (Kryder-Reid and May, 2023). By presenting the methods and results of two story-writing activities in the Pacific we demonstrate, as proof of concept, how an archaeological framework can be used in educational and team-building scenarios through encouraging story-writing on MPL as artefacts representative of the surrounding toxic heritage provoked by plastic pollution.

Narrative workshops as archaeological interventions

To address plastic waste more tangibly, we developed an approach centred around MPL as artefacts. The use of plastic objects in workshops has already proven successful. McKay, Perez, and Xiaoyu, (2021) developed story-telling and art-marking activities using plastic waste in the Philippines. In the Pacific, Schofield *et al.* (2020) used MPL and the World Café approach to reconstruct the objects' journeys before reaching the archipelago of Galapagos. Both approaches proved to be successful engagement activities on the topic of plastic use and pollution, which served as an inspiration for our work. The former study asked craft-makers in the Philippines about plastic objects and how these were used locally. In that sense, stories emerged from the plastics and were portrayed in an exhibition contextualising

a series of plastic objects. The latter study explored MPL more specifically through the reconstruction of narratives in groups and a careful visual analysis of the objects. Both projects emphasised the potential of approaches that use object-oriented perspectives on material culture to engage in the topic, respectively encouraging people's engagement with plastics and fostering discussions about human behaviour and plastic waste. Building on the study led by Schofield *et al.* (2020), we used specific macroplastic items to engage schoolchildren individually on the topic of plastic pollution in Latin American Countries along the East Pacific Coast and on the island of Santa Cruz, part of the Galapagos archipelago. While the story-writing activities were also designed as a research project to approach local perceptions of the issue, the focus is here on the methods to undertake the activities themselves and the success of their implementation in those two case studies.

The main goal of our approach was to provide the opportunity for people to use evidence of an object combined with their knowledge of marine pollution processes to narrate an object's journey, in the form of a written story, an illustrated story, or a comic. To do this, participants were asked to answer individually a series of questions addressing the nature of the object (its function, age), its use (by whom and how), its becoming waste (how it reached the environment), its journey (the interactions it had with the environment), and the potential solutions to prevent MPL's entry into the environment. Participants also answered a pre-survey before the activity and a post-survey to evaluate changes in self-reported knowledge, perceptions, and pro-environmental behaviours, as well as to gather participants' feedback on the exercise. The aim of those activities was threefold. To: 1) use an archaeological lens into the issue of plastic pollution through the use of object itineraries, 2) provide an engaging activity on the topic of plastic pollution, in this case in the Pacific, and 3) understand local perceptions of the issue of plastic pollution and how the activity impacted perceptions, self-reported knowledge, and pro-environmental behaviours. The use of object itineraries (Aim 1) to approach MPL as artefacts is presented in the next section.

The reason for adopting an ‘object itineraries’ approach

Plastics are materials that have a complex chain of custody and often take a global journey before entering our local environment. The concept of “global unlocality” means that plastic waste is often untraceable (Davis, 2022), and undertakes a global journey (as evident in the Flip Flop Trail, Knowles, 2015). Plastics also embody and replicate colonial mechanisms (Liboiron, 2021). Those aspects contribute to plastics becoming complex objects whose toxicity can span generations. To consider plastics as archaeological objects of research and eventually artefacts, we used the framework of object itineraries (as theorised by Joyce, 2015, 2017). Object itineraries allow us to de-center the human by thinking of how plastic artefacts interact with humans and non-humans alike and exist in the environment, and to acknowledge their global and complex journey before becoming marine plastic litter. This framework offers a window into global and complex artefacts of the Anthropocene such as plastics, in a much better way than object biographies and life histories (see Praet *et al.*, 2023a for an evaluation of the framework for plastic objects).

Case studies

The East Pacific Coast

The first study adopting this method was undertaken in Latin American countries along the East Pacific Coast in collaboration with the Red de Científicos de la Basura (ReCiBa), literally translated as the Litter Scientists network; for more background information about the network see De Veer *et al.* (2022) and Thiel *et al.* (2023). A call to teachers was sent and those interested got involved in the activity with their class. All the resources necessary to participate in this project would be available on an app as the study took place in 2020, a period marked by repeated lockdowns during the COVID-19 pandemic; this app was generated to provide teachers with a tool to support their remote teaching activities imposed on them and the schoolchildren by the lockdowns. Participants were presented with a series of resources on the app guiding them through the story-writing activity. These resources comprised: an [informative video](#), an [instruction video](#) for the story-writing activity, the surveys, a gallery with pictures of 26 MPL objects that had been previously collected by

students during the 2019 litter sampling that ReCiBa organised, and the parental consent (Praet *et al.*, 2023b). The ReCiBa team and the teachers who had received relevant training in using the app were available to help participants and to ensure parental consent was obtained before publication of the stories online (for general communication strategy see also Thiel *et al.*, 2023). The [network website](#) presents the different projects and the stories are available on [Zenodo](#).

The results of the data analysis of stories and surveys were published in the journal *Marine Pollution Bulletin* in 2023 (Praet *et al.*, 2023b). The results of the online story-writing activity showed engagement from participants and a significant increase in pro-environmental behaviours as a result of participation (Table 1; Praet *et al.*, 2023b, Supplementary Materials). Participants noted that they knew more about MPL after the activity (3.64 ± 0.75) compared to before (3.50 ± 0.75 , $Z = 2.20$, $p = 0.03$ with the difference being significant as $p < 0.05$) (Praet *et al.*, 2023b). Participants also reported that they enjoyed the activity (average of 4.58 ± 0.57 on a scale from 1=not at all to 5=very much) and were very likely to recommend it to others (4.36 ± 1.00) (Praet *et al.*, 2023b).

Table 1: Answers to the pre- and post-surveys (Table adapted from Praet et al. 2023b, Supplementary materials). When the difference between pre- and post-survey is significant, the result is highlighted in green.

Item	Before		After		Difference	Scale
	M	SD	M	SD	Inferential statistics	
Self-reported knowledge						
How much do you think you know about plastic marine litter? ^a	3.50	0.75	3.64	0.75	Z = 2.20, p = .03	From 1-I don't know anything to 5-I know a lot
Perceptions						

Plastic marine litter greatly affects the appearance of beaches. ^b	4.84	0.56	4.75	0.58	p = .12	1-I strongly disagree to 5- I strongly agree
It is common for plastic marine litter to harm wildlife around the world. ^b	4.43	0.99	4.44	0.93	p = .89	1-I strongly disagree to 5- I strongly agree
The marine food chain contains small pieces of marine plastic debris (for example, large animals that eat smaller animals that have eaten plastic) ^b	4.25	1.03	4.36	1.00	p = .27	1-I strongly disagree to 5- I strongly agree
The way my family and I treat our household garbage can affect the garbage in the sea. ^b	3.20	1.29	3.20	1.30	p = .80	1-I strongly disagree to 5- I strongly agree
I know how I can reduce marine plastic litter. ^b	3.74	1.12	3.81	1.01	p = .37	1-I strongly disagree to 5- I strongly agree
What is your interest in learning more about plastic marine litter? ^c	4.51	0.73	4.48	0.76	p = .52	From 1-no interest to 5-A lot of interest
How important is it to you to reduce plastic marine litter? ^d	4.79	0.47	4.74	0.59	p = .36	From 1-No importance to 5-A lot of importance

Self-reported behaviour

Pick up the trash that is on the ground around my school. ^e	3.08	0.85	3.56	1.03	Z = 3.50, p < .001	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time
Pick up the garbage that is on the ground from the streets of my neighborhood. ^e	2.74	1.03	3.46	1.15	Z = 4.77, p < .001	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time

Pick up the trash found on the beach. ^e	3.23	1.12	3.69	1.09	Z = 4.61, p < .001	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time
Recycle packaging. ^e	3.68	1.06	4.08	0.96	Z = 3.33, p = .001	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time
Try to convince family and friends to use less single-use plastic. ^e	3.44	1.22	3.70	1.14	Z = 2.20, p = .03	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time
Try to convince people in your community to use less single-use plastic. ^e	2.60	1.29	3.26	1.23	Z = 4.64, p < .001	1-Never, 2-Rarely, 3-Sometimes, 4-Often, 5-Every time

The analysis of stories also showed the potential of undertaking qualitative analysis of narratives centred around MPL. The thematic coding strategy revealed a good understanding of plastic pollution sources, reflecting the regional reality with a predominance of land local sources (see Praet *et al.*, 2023b for a thorough discussion of the codes). Regarding MPL's impacts, participants indicated a concern for landscape in the surveys and wildlife in the stories, particularly fish and turtles. There was a diversity of solutions presented in the stories, contrasting with the surveys emphasising the importance of recycling. Most solutions were realistic confirming a trend that Wichmann *et al.* (2022) identified with little emphasis on reducing plastic use. They also showed that few participants offered imaginative solutions but when they did, some were very creative, for example, litter collection with the help of a spaceship (Wichmann *et al.*, 2022) While the results of thematic coding revealed several trends (as noted above), they are not the focus of this short piece, which addresses the potential of story-writing workshops as a tool to engage on the topic of plastic waste as a toxic heritage.

Galápagos

The second study consisted of a series of two in-person workshops undertaken on the island of Santa Cruz, the most populated island of the Galapagos archipelago. The first workshop was a two-hour session, where students completed the pre-survey, self-assessing their understanding of MPL and their pro-environmental behaviours (PEBs). These workshops were explicitly using an archaeological framework, starting with a description of archaeology and explaining the potential of visual analysis to understand plastic waste. A selection of 11 objects was distributed to the students, The objects, combining fishing-related and domestic MPL, were presented to the students who analysed them in groups, answering a series of seven questions: What is the object?; How old is it?; Where does it come from?; How was it used and by whom?; How did it reach the sea?; How did it interact with the environment?; What actions could have prevented the object from ending up on a beach? The participants then used their findings to write or draw an individual story reconstructing the object itinerary. A second workshop was organised to collect the stories along with the consent forms and complete the post-survey (including feedback). If there was extra time, a similar exercise was adopted to re-construct orally and in small groups the itinerary of prehispanic artefacts, noting the usefulness of our familiarity with plastic objects when undertaking such a task.

The results of the data analysis show good awareness of MPL origins, reflecting the specific pathways of litter notably reaching the Galapagos archipelago from mainland South America, originating from regional marine activities including fishing in and around the Galapagos Marine Reserve, and eventually from local sources although those are considered to be limited. It also reflects a good grasp of the impacts, with a preoccupation for bio-ecological impacts notably the impact on emblematic animals such as turtles and fish as an important contributor to local livelihoods. Yet, there is a lack of focus on solutions in the stories. The surveys, however, illustrate the emphasis on recycling PEBs. Altogether, these findings suggest that more targeted activities are needed to picture the need for complementary solutions, eventually placing more emphasis on reducing plastic in

the first place. While the feedback from participants indicates that they enjoyed the activity (4.49 ± 0.74 ; on a scale where 1=totally disagree and 5=totally agree), learned about the issue of marine litter (4.33 ± 1.05), its origins (4.21 ± 1.17) and impacts (4.03 ± 1.27), and would recommend the activity to others (4.2 ± 1.17) (Figure 1), the workshops did not have a significant impact on PEBs or self-reported knowledge. A difference in sample size (East Pacific Coast: 81 stories and 79 surveys; Galapagos: 161 surveys and 137 stories), nature of the workshops, and type of MPL used along the Pacific coast and in Galapagos may influence those results but more research is needed to determine this.

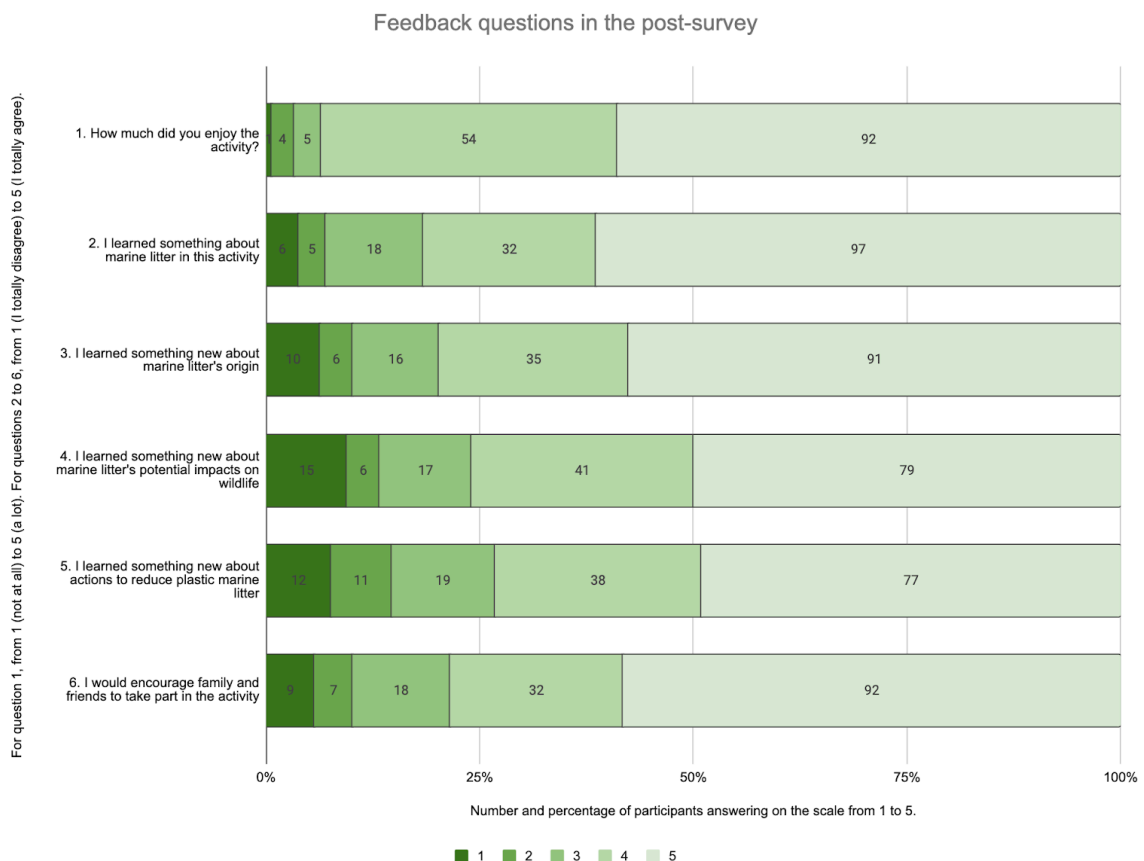


Figure 1: Feedback from participants to the workshop in Galapagos

Resources

This short essay highlighted the positive feedback gathered for both case studies and the significant change in PEBs for the East Pacific Case Study. As the activity proved to be an engaging activity with positive feedback from participants in the

Galapagos and along the East Pacific Coast, resources used for both case studies are provided in English and/or Spanish and can be used for workshops by teachers, educators, and facilitators in team-building or corporate settings. It should be noted that surveys are necessary only when the project results are also used for research purposes. In that case, an ethical clearance must be obtained first, along with the consent of participants (and consent from a responsible adult if they are minors).

Table 2 presents the set of resources used for the workshops for both case study. It should be noted that the online nature of the first case study required professors taking part in the project to attend a training session. This training session aimed at providing teachers the necessary resources to support students during the activity. Teachers played a key role between students and researchers. In contrast, the Galapagos workshops were all undertaken in person by the researchers, A.G. and E.P., who ensured consistency in the format and approach, and obtaining consent.

Table 2: Set of resources available to replicate the study

Resources	East Pacific	Galapagos
MPL objects	A selection of 26 domestic MPL objects locally collected	A selection of 11 fishing-related and domestic MPL objects collected locally
Surveys	Pre- and post-surveys (Spanish and English)	Pre- and post-surveys (Spanish and English)
A set of guiding questions	(1) What is the object and where is it from? What is it made of? (2) How was it used and who used it? (3) How did it end up in the ocean? (4) How did it interact with marine life? (5) What was the consequence of this interaction? (6) What human actions or behaviours caused this outcome? What actions or behaviours may have prevented this outcome?	(1) What is the object? (2) How old is it? (3) Where does it come from? (4) How was it used and by whom? (5) How did it reach the sea? (6) How did it interact with the environment? (7) What actions could have prevented the object ending up on a beach?

Guidelines	Guidelines for educators and teachers (Spanish) Informative video (Spanish) Instruction video (Spanish) Video discussing the application (Spanish) Presentation for the students (Spanish)	Workshop and activity guidelines step by step (Spanish and English)
Extra		If more information on plastic pollution sources, impacts and solutions, specific to Galapagos are needed, those PDFs can be used and shared.

Comparison between both studies

The case studies both contribute to understanding the issue of marine plastic litter in the Pacific, contributing to the broader [Pacific Plastics: Science to Solutions](#) (PPSS) programme. By adopting a similar methodology, the case studies offer a way to compare a resolution at a regional scale along the East Pacific Coast, and the local scale of Santa Cruz in the Galapagos archipelago. This section briefly discusses the differences and similarities in design, delivery, and results of the two studies presented above, useful for shaping potential recommendations.

The design of the East Pacific case study was undertaken by a multi-disciplinary team looking at a regional perspective on the issue and preceded the Galapagos workshops. Building on this first regional approach, it seemed important to adapt some questions to the specific context of Galapagos, a World Heritage Site particularly valued for its unique biodiversity. The guiding questions for the story-writing exercise concern the same aspects of MPL (origin, use, behaviour leading to disposal, journey of the object, actions to prevent MPL). They may use slightly different wording in the Galapagos case study to focus on one aspect of MPL per question and include the consideration of an object's age, building on the archaeological lens explained in the workshops. Some survey questions also differ to reflect the local context of plastic pollution in Galapagos and were developed

following the opportunities highlighted by the first case study (see the conclusion of Praet *et al.* 2023b). From that perspective, the survey questions for Galapagos recognised the main plastic pollution sources, including a remote origin (insinuating the mainland or further afield), an origin from fishing activities, and local sources. Elements outlined by Praet *et al.* (2023b) were considered in the Galapagos case study, notably the potential impact on human health and the difference between domestic and fishing-related MPL, leading us to select domestic and fishing-related MPL for the story-writing activity.

The recruitment and the delivery of the workshops were also different. While the first case study relied on the existing ReCiBa network of teachers engaged and interested in environmental activities, the selection of schools for the project in Galapagos was dependent on teachers and heads of schools' interest in the activity, determined by A.G. The selection in Galapagos was further limited to two schools, with over 300 participants, due to time restrictions and team capacity to analyse the results. The East Pacific case study also required specific training of teachers online before undertaking the activity (available in Table 1) contrasting with the in-person nature of workshops in Galapagos where only E.P. and A.G. delivered the workshops. The in-person workshops in Galapagos also clearly adopted an archaeological lens, possibly contributing to themes specifically reflecting on the different aspects of object itineraries (see Praet *et al.*, 2023a for a discussion on this topic). While the instructions for the stories to follow a narrative structure were the same, the positionality of A.G. and E.P. may also have influenced the focus of the stories in Galapagos. Additionally, the Galapagos workshops were group activities in the first part and then required individual stories. Some participants may have created similar stories, contrasting with the more isolated undertaking of story-writing for the East Pacific case study amid the COVID-19 lockdowns. Finally, the mandatory nature of the students' participation in Galapagos, as part of the curriculum at the Unidad Educativa Nacional Galapagos (UENG), contrasts with the voluntary participation of the ReCiBa network (although schoolchildren were also encouraged by the teachers to participate in the activity). With only the most motivated participants writing their stories and submitting those online for the first case study, this level of engagement may have influenced the results, particularly the significant impact the workshops had notably on participants' PEBs. For the East

Pacific case study, several participants were also engaged and interested in the topic beforehand, having taken part in other ReCiBa activities, which is not the case for most Galapagos participants.

Results of both case studies share a similar understanding of local sources of plastic pollution, and the emphasis on the harmful impacts that MPL can have particularly on turtles and fish, animals respectively emblematic and important for local livelihoods. The consideration of Galapagos species in the second case study may also be related to the importance of nature in the WHS of Galapagos, along with a discourse on Galapagos uniqueness, a theme identified by Praet *et al.* (2023a). This concern for nature may also be related to its key role in tourism, an activity important for many families in the archipelago. An interesting difference is the prevalence of accidental behaviours leading to object disposal in Galapagos contrasting with the often intentional behaviour along the East Pacific. This may result from the type of MPL, with accidental behaviours most often associated with fishing contrasting with intentional public littering (Wyles *et al.*, 2016). Contrasting with the first case study on the Pacific coast where more than 75% of stories included potential solutions, less than a third of Galapagos participants included solutions in their stories. This may be linked to participants' level of engagement previous to the activity and self-reflection being more encouraged during the lockdowns. A detailed discussion of the Galapagos case study, along with a comparison to the first case study, is developed in a paper currently under revision (Praet and Guézou, under revision).

Recommendations

The circumstances of the East Pacific Case Study required the activity to be undertaken online through an application that would facilitate completing the activity without a reliable internet connection, as only uploading the story required a stable connection. Looking back, we consider that an application possibly was not always straightforward but this approach was the only way to offer teachers of the network, who play a key role in the research ReCiBa undertakes, an option to engage their schoolchildren in an activity during the COVID-19 pandemic. While in-person

workshops are often the best alternatives, the positive results of our study indicate that alternative formats can be efficient engagement tools during times of crisis and provide a comparison between local perspectives from different countries at a lower cost.

The Galapagos story-writing workshops yielded very positive feedback but did not impact PEBs in such a significant way as the first study on the East Pacific Coast. This may be due to the sample size, the type of engagement with only the most engaged students participating in the online story-writing activity (contrasting with the whole class participating in Galapagos), and the nature of the workshops (online vs in-person). The nature of MPL may also have impacted those results with participants more likely to grasp their contribution to the issue with domestic MPL than with fishing-related MPL. The socio-economic context, the capacity of action at the household level, gender and age may also be factors influencing the results.

In conclusion, these various types of workshops proved effective in different ways, notably in terms of engagement and education. These are also workshops that can be organised quickly, easily, and at low cost, provided that facilitators are available. In short, and in addition to facilitators, to undertake this workshop successfully, you will need: a set of objects collected, for example on local beaches; a guide to the creation of narratives; and a set of guiding questions. As Schofield and Pocock said in the accompanying Toxic Heritage volume (2023, 63-64), environmental pollution has been described as a wicked problem (and see Schofield 2024). Wicked problems are hard if not impossible to resolve, but contributions can be made at a local scale through finding creative solutions that constitute small wins. It is in that context that we present this methodology and the examples that demonstrate its success. The case studies presented contribute to enhancing the importance of these actions, particularly for [the development of a mitigation and/or prevention plan for marine plastic litter](#). Engaging participants in these actions is not only a way to identify and quantify the issue, but their participation often encourages them to take concrete positive actions. Here, considering marine plastic litter as artefacts and toxic heritage boosted PEBs and engaged students on the topic in a creative activity. In a similar way that plastic reaches all parts of the globe, we hope

that those small wins against the wicked problem of plastic pollution can reach different shores.

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