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Bottle with a message: The role of story writing as an engagement tool to explore children's perceptions of marine plastic litter

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ABSTRACT

As human behaviors play a crucial role in addressing the global threat of plastic pollution, it is vital to understand perceptions about marine plastic litter (MPL) and to develop interventions encouraging pro-environmental behaviors (PEBs). This study evaluates story writing as a window to explore perceptions and as an engagement activity to boost PEBs. During the COVID-19 lockdowns, schoolchildren from the East Pacific coast participated in this activity, each creating a story and answering a pre-post survey. Qualitative and quantitative analysis of 81 stories and 79 surveys show awareness of sources and impacts. Participants identified land and local pollution as significant contributors to MPL and emphasized bio-ecological impacts, reflecting concern for landscape and wildlife. While the stories presented a diversity of solutions, recycling dominated the surveys. As participants reported an increase in self-assessed knowledge and improved PEBs after this activity, it can be seen as an engagement tool to encourage behavior change.

1. Introduction

Marine plastic litter (MPL) presents a global challenge that is deeply linked to human behaviors. Whether land- or ocean-based, all litter share a common interaction with humans (Sheavly and Register, 2007). At individual, industrial or governmental level, decisions are made by humans who (in)directly and (in)voluntarily contribute to the issue of MPL. This complex issue poses a global threat to our societies and to the environment (MacLeod et al., 2021). To better address this issue, it is important to understand the sources and impacts of MPL in order to help design solutions. While marine biology, environmental and policy studies can help evaluate different aspects of MPL, behavioral sciences have long emphasized the importance of how people perceive and consequently act towards plastic litter (Pahl and Wyles, 2017).

Despite its importance, the theoretical framework behind the term 'perception' is almost never described in MPL studies where it is often

used to refer to public (e.g. Hartley et al., 2018) or to risk perceptions (e.g. Oturai et al., 2022). We here follow Brewer (2011) in considering perceptions as conscious acquaintances of physical objects that vary according to the perceiver's circumstances and their point of view. Perceptions of MPL by the public are then defined by a series of interactions with the environment, local context and societal beliefs among other things (see Tuan, 1974 for the impact of culture and environment on perceptions; see Wolf and Moser, 2011 for an example of these influences in perceptions of climate change). In this paper, perceptions are differentiated from knowledge (understanding of the facts) and awareness of the issue (consciousness of its existence). While someone might be *aware* that plastic pollution is an issue, they do not necessarily *know* where MPL comes from but still have *perceptions* of the sources by looking at an object or the surrounding environment, even if those perceptions can be misconceptions (see La Fuente et al., 2022 for misconceptions of plastic types). We acknowledge that perceptions can

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contribute to epistemological processes (see Cassam, 2008 for a discussion on perception as a source of knowledge) but acquisition of knowledge relies on other elements (see Brewer, 2011, Chapter 6). Along with their importance to tackle plastic pollution, the variation in perceptions of MPL has probably contributed to a recent interest in studying them through surveys (e.g. Forleo and Romagnoli, 2021; Soares et al., 2021), questionnaires and interviews (e.g. Rayon-Viña et al., 2018; Van Rensburg et al., 2020) or as part of wider engagement activities (e.g. Rayon-Viña et al., 2019; Oturai et al., 2022).

Several activities have been designed to evaluate perceptions along with knowledge of MPL while also acting as engagement tools on the topic. For example, some environmental education projects aim at improving the understanding of the local context (Hartley et al., 2015; Owens, 2018; Locritani et al., 2019; Salazar et al., 2022). Citizen Science (CS) projects (i.e. collaborations with non-professional scientists such as children engaging in science) have been shown to improve perceptions of sources and impacts of plastic pollution, often leading to increased concern for the issue (e.g. Locritani et al., 2019) in addition to contributing to data collection (e.g. Hidalgo-Ruz and Thiel, 2015). As a more hands-on experience, beach clean-ups have allowed participants to become familiar with the bio-ecological impacts of MPL. Such activities appear as good tools to improve local perceptions of MPL while encouraging people to take action (Rayon-Viña et al., 2019).

The frequency of participation might also influence perceptions with recurrent participants showing higher levels of concern for the issue of plastic pollution (e.g. Oturai et al., 2022). Independently of factors leading individuals to participate in beach clean-ups (e.g. socio-cultural context in Rapa Nui in Kiessling et al., 2017; previous participation and feeling of collective responsibility in Lucrezi and Digun-Aweto, 2020; socio-demographic and travel characteristics in Adam, 2021), participation seems to boost marine awareness, environmentally responsible intentions (Wyles et al., 2017) and behaviors (Owens, 2018). While activities can contribute to approach and improve perceptions of MPL's sources and impacts, they can also present solutions to the issue and encourage participants to take action. Other activities share a focus for driving change in human behaviors, as a solution to MPL. For example, communication, educational and information campaigns try to raise awareness (Belontz et al., 2018) and eventually influence human behaviors to reduce, reuse and recycle (3R's campaigns), and to not litter (e.g. Rayon-Viña et al., 2019).

While the issue is complex, all aspects of MPL including sources, impacts and solutions can be better understood through the itineraries of littered objects. A focus on macroplastics makes the issue more tangible, and contributes to engaging the public on this topic, about which they feel less informed than microplastics (Frias and Nash, 2020). Investigating the larger objects through an archaeological lens, as artifacts (e.g. Schofield et al., 2020), can help understand the behaviors leading to their disposal and dispersal, for example by looking closely at details of each object (e.g. labels and weathering) and acknowledging the impacts it might have if it remains within the environment. The objects also serve as a basis to think about potential alternatives and solutions in design and materials. Everybody can relate to these often familiar plastic objects yet people's perceptions of them will vary. While these perceptions can be multi-sensorial (see Tuan, 1974), we focus here on visual perceptions that emerge on seeing either the object or a picture of it. By considering MPL as material culture (as artifacts) representing behaviors from the recent and contemporary past (e.g. Harrison and Schofield, 2010), stories can be created from the objects' characteristics that compose their unique itineraries. The concept of object itinerary was proposed by Joyce and Gillespie (2015) to consider the journey that archaeological artifacts take over time and the set of relationships they weave with humans and non-humans along the way. The geographical component of MPL journeys as well as their temporality outliving humans (especially as waste) makes the framework of object itineraries (Joyce, 2015) particularly relevant to address MPL.

Considering plastics as artifacts, each with its individual itinerary,

allows for the visual identification of elements informing the different processes that each artifact has been subjected to, from production to use and disposal. Some elements of the object itinerary will remain unknown, yet those gray areas can still become an active part of the object itinerary through speculative or creative fiction. Creating fictional stories based on elements that belong within the object itineraries can help their authors to reflect on the plastic pollution problem. Inspired from behavioral sciences, story-telling and writing have been adopted as a method to engage people more efficiently (Moitra, 2014), connect them to their environment (Fanini and Fahd, 2009), and help them to reflect on their behaviors (Schofield et al., 2020). Several studies have confirmed the potential of creating stories based on artifacts (e.g. Aerila et al., 2016), including plastic waste (e.g. Schofield et al., 2020; McKay et al., 2021).

The use of stories to reconstruct an object itinerary of MPL has been proposed and later trialed by Schofield et al. (2020) in Galapagos in 2018. In that earlier study, adults were asked six questions in order to develop a story for a number of pre-selected MPL items (e.g. a child's shoe, a bottle with a toothbrush in it, the torso of a doll) regarding the origin, use, and journey of the object, as well as human behaviors that either provoked this outcome or could have prevented it from happening. By developing hypothetical stories built around evidence derived from examining each object (e.g. lettering and date stamps as well as the physical appearance of stranded plastic litter, such as fragmentation, evidence of biofouling, exposure to the sun), participants did come to recognise that human behaviors are at the root of plastic pollution (Schofield et al., 2020). Thus, these stories can help to identify and understand those human behaviors and thereby contribute to mitigating or reducing pollution.

In addition to providing an engaging activity for participants to reflect on MPL, stories can be analyzed for what their content reveals about the beliefs of their authors (Savin-Baden and Howell-Major, 2013, Chapter 19). While knowledge and perceptions of MPL were traditionally evaluated through surveys (e.g. Forleo and Romagnoli, 2021; Krelling et al., 2017), other methods such as story writing can generate a richness of data (see open-ended questions in Pearson et al., 2014) that can complement these traditional surveys. Stories can therefore be an innovative way to portray perceptions, and whilst they were not designed to provide a comprehensive record of the participants' perceptions of MPL, they can provide insight into some of their views about this global socio-environmental issue. Beyond what the content of the stories tells us about meaning and beliefs, the potential of activities with plastic waste was noted by McKay et al. (2021, p241) who organized a workshop of art-making and story-telling with plastic waste, considered by participants to be "enabling". While story-telling has therefore proved useful for participants to reflect on plastic waste, the potential of individually writing stories about MPL objects has not yet been explored.

An audience particularly keen on creating stories are children (Aerila and Rönkkö, 2015). Several studies have shown the potential of writing for children to share their experiences in an open manner through narratives (Foster, 2017) and to process information in a different way by creating stories (Aerila et al., 2016). Aside from being a powerful tool in education and various forms of therapy, the content of stories can also serve as a basis for analysis to better understand how children express their experiences (e.g. trauma in Foster, 2017) and their perceptions of the world around them (e.g. through artifacts and historic sites in Aerila et al., 2016). On the topic of MPL, schoolchildren's perceptions have been scarcely explored (e.g. Rayon-Viña et al., 2019) despite being a particularly interesting audience with high levels of environmental concern (i.e. an inquietude for the surrounding environment) and awareness of plastic litter (Oturai et al., 2022; Wichmann et al., 2022). Children also share a sense of responsibility (i.e. a sense of obligation to resolving the issue of plastic pollution), which seems correlated to the adoption of pro-environmental behaviors (PEBs) (defined as "behaviors that consciously seek to minimize the negative impact of one's actions on

the natural and built world", after Kollmuss and Agyeman, 2002, 240; see also Jensen, 2002 for problems associated with the use of this concept) (Benyamin et al., 2018; Bettencourt et al., 2021). In addition to their awareness, concern and sense of responsibility, children can positively influence peers, family members and the broader community (Hartley et al., 2015; Salazar et al., 2022) while being careful observers of their environment, especially noticing litter in natural settings (De Veer et al., 2022).

The story-writing activity, conceived as an engagement tool and a way to explore perceptions of MPL sources, impacts and solutions in stories, was undertaken with schoolchildren from the Latin American Countries (LAC) along the East Pacific Coast. In the region, MPL mainly comes from local land sources (Silva-Íñiguez and Fischer, 2003; Hidalgo-Ruz et al., 2018; Honorato-Zimmer et al., 2019; Gaibor et al., 2020; Garcés-Ordóñez et al., 2020a). The main economic activities generating MPL in the region are tourism (Williams et al., 2016), as well as fishing and aquaculture (Ribic et al., 2012; Van Gennip et al., 2019), which are fundamental activities for the economy of these countries (e.g. Chuen-pagdee et al., 2011; Chevallier et al., 2021). As elsewhere, MPL has impacts on wildlife in the region (e.g. Thiel et al., 2018) with emblematic marine species threatened (e.g. sea turtles in Geary, 2019). It also affects marine ecosystems with high importance for conservation (e.g. Luna-Jorquera et al., 2019), tourism (Krelling et al., 2017) and other coastal activities (Rodríguez et al., 2020). Regional solutions to MPL include a series of measures such as policies to limit single-use plastics (Amenábar Cristi et al., 2020; Ortiz et al., 2020), fines for litterers and environmental education (Eastman et al., 2013) and better waste management systems (Valerio et al., 2020), although there is little recognition of the informal reuse of plastic waste through scavenging (Brooks et al., 2020; Medina, 2015).

While the region's sources and impacts of MPL have been widely investigated (e.g. Alfaro-Núñez et al., 2021; Gaibor et al., 2020; Garcés-Ordóñez et al., 2020a, 2020b; Honorato-Zimmer et al., 2019; Thiel et al., 2018, 2021), only a handful of studies have investigated educational activities on the topic (e.g. Hidalgo-Ruz and Thiel, 2015; Wichmann et al., 2022) with one study evaluating children's perceptions of litter in urban and rural environments (De Veer et al., 2022). The present paper contributes to the gap of studies investigating education initiatives around MPL in Latin America (Bettencourt et al., 2021) by evaluating if a story-writing activity involving the itineraries of plastic artifacts acts as an effective engagement tool and as a window to explore local perceptions.

2. Methods

To explore schoolchildren's perceptions of MPL's origins, impacts and solutions and to create an engaging activity in the context of the Pandemic, we designed the project "*My Story of Plastic Litter: a Journey to the Ocean*" and shared it through the Latin American Network of Litter Scientists (Red de Científicos de la Basura – ReCiBa). Since 2018, the CS program ReCiBa has brought together scientists, teachers and school-children (10 to 18 years old) from LAC of the Pacific Coast to generate scientific data about litter sources, distribution and impacts, and use scientific environmental education as a marine conservation strategy. ReCiBa currently works with around 800 students from different schools in the region. While most schools have participated since the first collaborative research in 2018, new schools (and/or schoolchildren) join the network each semester. So far, ReCiBa has conducted an environmental exploration (Second Semester 2018; see De Veer et al., 2022), a questionnaire survey of their local communities (First Semester 2019), and a sampling of litter interacting with biota (Second Semester 2019). For the purpose of this paper, schoolchildren will be referred to as participants of the study.

In 2020, during the global lockdowns that characterized the COVID-19 Pandemic, we sent a call to the ReCiBa network of teachers, gave an online presentation of the activity and distributed an outline of the "*My Story of Plastic Litter*" project to teachers interested with the dual aims of exploring elements stressed in stories written by schoolchildren on the Pacific Coast regarding MPL's sources, impacts and solutions, while providing an activity to engage with the topic when required to learn from home. The activity required participants to produce a story or a comic strip about the journey of a suggested plastic object (listed in Appendix 1) and to answer two surveys, before and after the activity, to assess the impact of participation on their self-assessed knowledge. Activities were designed by the project team, comprising an interdisciplinary group composed of professionals in the field of marine biology, education, environmental psychology and archaeology.

2.1. The activity

Due to the Pandemic and local difficulties to access the internet, ReCiBa decided to undertake the activity through a mobile application that only required connectivity to download the story-writing instructions and the surveys, and then later upload the completed stories and surveys. The ReCiBa app guided the participants through the process by including: an informative video about the first survey, the first survey, an instruction video for the story-writing activity, a gallery with images of 26 MPL objects (previously collected by students participating in the 2019 litter sampling organized by ReCiBa; Appendix 1), a section into which they could write the story directly (or upload it as text or image), the second survey, and the parental consent. The different steps were clearly presented in the videos for the participants, and teachers were tasked to ensure that parental consent was obtained at the end of the submission to allow the analysis and publication of the stories online. Along with the ReCiBa team, teachers played an essential role to help the students use the app and to ensure access to the data. It should be noted that the remote nature of the activity makes it difficult to assess if adults helped during the creation of the stories. Yet, no story had a writing style that stood out as unlikely to be written by schoolchildren.

To motivate the participants to write a story, the objects chosen were items commonly found on local beaches and recognizable as everyday items, such as a toothbrush, a plastic bag or a straw. We encouraged participants to choose an object among the gallery that can easily be found at home. They were then asked to create a story that would answer the following orienting questions in Spanish (after Schofield et al., 2020 who used these same questions to create a narrative with groups of adults and teenagers in Galapagos): (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 behaviors caused this outcome? What actions or behaviors may have prevented this outcome? These questions all refer to different aspects of an object's itinerary (as theorized by Joyce, 2015). Careful observation of the object might help answer those questions and fictional writing can fill those gaps to recreate the itinerary of the object from its origin (question 1) to its disposal (questions 2 and 3), leading participants to think about impacts (questions 4 and 5) and solutions (question 6). Building on those elements, participants could either write a story of 500 to 1000 words (following a structure with introduction, development and conclusion written either in first or third person), or draw a comic strip of 10 to 20 vignettes that would later be uploaded onto the project website. The stories themselves show a good understanding of the instructions by participants through the choice of an object from the gallery, the respect of the wordcount and the narrative structure present in most stories.

2.2. The surveys

To assess the effects of this activity on behavior and perception of the participants, a short questionnaire survey was administered via the app before and after the story task (Appendix 2). This included five groups of questions. First, standard demographics were reported (e.g. age, gender,

country and distance to the coast). Second, the survey asked participants to state their self-assessed level of knowledge about MPL on a scale from 1 "*I do not know very much*" to 5 "*I know a lot*" (as previously used by Wyles et al., 2017). Third, participants were asked about their perceptions and experiences relating to MPL. This included stating their level of agreement (from 1 "*strongly disagree*" to 5 "*strongly agree*") to statements about the impacts MPL can have (e.g. "*It is common for wildlife to be harmed by marine plastic debris around the world*"), their perceived behavioral control over the issue (e.g. "*I know how I can reduce marine plastic waste*"), and how important they find this issue (this was guided by theories of behavior, such as the Theory of Planned Behaviour, after Ajzen, 1985, and questions employed in previous surveys, e.g. Hartley et al., 2015 and Abate et al., 2020). Fourth, to examine self-reported behaviors, participants were asked how often they adopt certain behaviors, from picking up litter, to recycling (i.e. waste classification at home) and to encouraging others to act more sustainably, on a scale from 1 "*never*" to 5 "*all of the time*" (based on questions used by Hartley et al., 2015 and Wyles et al., 2017). Finally, participants were asked to name one thing they could do to prevent plastic litter from reaching the ocean.

The post-survey (Time 2-T2) asked the same questions as the pre-survey (Time 1- T1), but also asked additional feedback questions. Specifically, participants were asked to state how much they enjoyed the activity from 1 "*I did not enjoy it at all*" to 5 "*I enjoyed it a lot*". They also stated their level of agreement (1 "*strongly disagree*" to 5 "*strongly agree*") on whether they learnt something new about (a) the sources, (b) the impacts, and (c) the solutions for marine plastic pollution; and whether they would encourage others to engage in the activity.

2.3. Recruitment and participation

In the first contact phase, the ReCiBa coordination team invited 44 teachers and over 570 schoolchildren from 11 countries. Teachers had a training session on 22 October 2020 and participants submitted stories between November and December 2020. In total, 89 children participated in some aspect of the exercise. The data were considered only if participants had given consent for analysis (N = 84). Besides, surveys were only analyzed when complete (N = 79) and stories when they followed a narrative structure (N = 81) (i.e. telling a fictional story with elements regarding characters, events and setting). Overall, participants

Fig. 1. Map of the participating schools to the project "My Story of Plastic Litter: A Journey to the Ocean".

in the activity were aged between 10 and 18 (13.78 ± 2.50, mean ± std), with more participation from female students (59 %) and from those who lived close to the sea (53 % lived within 10 km of the sea). They came from different schools in the following countries on the East Pacific Coast: Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama and Peru (Fig. 1). The project was conducted during the period of the global COVID-19 Pandemic and this exercise was designed and timed to give schoolchildren in this region an activity to engage with while the schools were closed and they were experiencing isolation.

3. Analysis

3.1. Surveys

Both the surveys and the stories offer a window of insight into the participants' perceptions on (1) sources, (2) impacts, and (3) the solutions to the issue of MPL. In addition, the evaluation of the activity as an engagement tool, reporting participants' feedback on the activity, explores any changes in their perceptions and behavioral intentions pre- and post-engagement. To examine participants' baseline views before the activity (T1) and to monitor if these changed after the activity (T2), the average scores of 79 surveys were statistically compared. As the data were not normally distributed, non-parametric statistics were used (Wilcoxon signed rank test). The demographic data are not discussed due to the small sample size.

3.2. Stories

The sample of 81 stories in Spanish was analyzed qualitatively on NVivo 2020 following thematic coding and the application of inter-coder reliability. The method can be summarized as follows (for a full description of the methods see Appendix 3).

a) NVivo coding

Following a hybrid approach of successive inductive (data driven) and deductive (following a set of predetermined codes) coding (see Appendix 3), themes were compared across stories based on the presence of codes and their popularity. A summary of the overarching codes (being aggregate categories of all individual codes) is presented in the following section (see Appendix 4 for the list of all codes, their description, and popularity). Numbers reported in the results section correspond to the quantity of stories presenting the codes (N = file) rather than the number of times a code was mentioned per story (n = references). As most codes that aggregated (AC) within an overarching code (OC) were not exclusive, several AC belonging to one OC can appear in the same file; therefore N of the overarching code was not always equal to the sum of N of aggregated codes ($N_{OC} \leq \sum N_{AC}$).

b) Inter-coder reliability (ICR)

Coding reliability was determined through ICR on a sample size (in English) of over 10 % between two independent researchers, respecting the sample size recommendation of O'Connor and Joffe (2020). ICR was undertaken in NVivo 2020 providing both a measure of agreement and a Kappa Coefficient (Woolf and Silver, 2018), the latter having the biggest consensus (McDonald et al., 2019) as it is accounting for the probability of agreeing by chance (Pykes, 2020). Our results (Appendix 5) yielded a 0.57 Kappa corresponding to a moderate agreement on Landis and Koch's (1977) scale and an average agreement of 98.82 %. The Kappa Coefficient on NVivo is based on character level and therefore is unsuitable for content analysis that relies mostly on sentences and paragraphs (Kim et al., 2016). While the Kappa Coefficient tends to underestimate the concordance, the average agreement overestimates it (McHugh, 2012). To address those limitations of both coefficients, we undertook an analysis of all disagreements (Appendix 6) and agreed on

some modifications to the codebook.

c) The codebook

The codebook was divided into four main categories encompassing codes belonging to the following overarching themes: the object as a user product, the object as waste, the solutions, and the structure of the story. All codes related to the use of the object (by whom and for how long) as well as the type of object and the emotions it felt while in use, were coded under the first theme. The second overarching theme encompassed the factors leading to the object becoming waste (in cultural and natural settings), its emotions and interactions with the environment along with their consequences (for the animals involved). The next theme included individual codes for the solutions that can either be preventive, aiming at avoiding litter entering the ocean in the first place, or reactive, offering solutions to removing MPL. Coding also considered the people exhorted by the story's author to take action. The fourth and final overarching theme gathered codes discussing the location where the story takes place ('country and movement of the object') and the protagonist of the story. The first three of the four overarching themes, respectively, allowed us to analyze: (1) the sources (better understood through the use of plastic as a product), (2) the impacts (visible in the codes regarding the plastic object as waste), and (3) the solutions to MPL. The fourth overarching theme offered contextual information about the role of the object and the extent of its journey as waste contributing to our understanding of the sources (Table 1).

4. Results

In choosing among a series of domestic plastic litter objects found on beaches on the East Pacific coast, students indicated a preference for a handful of objects. Out of the available 26 objects offered on the app, 15 suggested objects were identified in the stories. As participants had the possibility rather than the obligation to focus on an object presented in the app, some stories did not give enough elements to identify the object (N = 10, 12%; Fig. 2) or focused on objects that were not in the list (a biodegradable plastic ring, seahorse and dinosaur toys), resulting in total of 18 different objects discusse in the stories. The most common items featured in the stories (and coded as such) were plastic bottles (N = 11 of the 81 stories; 14 % where percentages are rounded to full numbers), toys if considered together (N = 11; 14%), plastic bags (N = 10; 12 %) and straws (N = 8; 10 %; Fig. 2). The stories mostly focused on objects that were used for less than a day before being discarded (N = 30; 37 %), with the use-life of objects being determined through temporal elements provided in the story (e.g. buying an item in the morning and losing it on the beach in the afternoon). When examining how the objects were used by characters within the stories, most were used by children and teens (N = 36; 44 %) compared to adults (N = 18; 22 %).

Table 1

Relationship between the guiding questions for the stories, the overarching themes in coding and the presentation of the results in this paper.

| Questions	Overarching themes	Results
What was the object and where is it from? What is it made of?	Object as a user product/ structure of the story	Sources
How was it used?	Object as a user product	Sources
How did it end up in the ocean?	Object as waste/structure of the story	Sources
How did it interact with marine life?	Object as waste	Impacts
What was the consequence of this interaction?	Object as waste	Impacts
What human actions or behavior caused this outcome? What actions or behavior may have prevented this outcome?	Solutions	Solutions
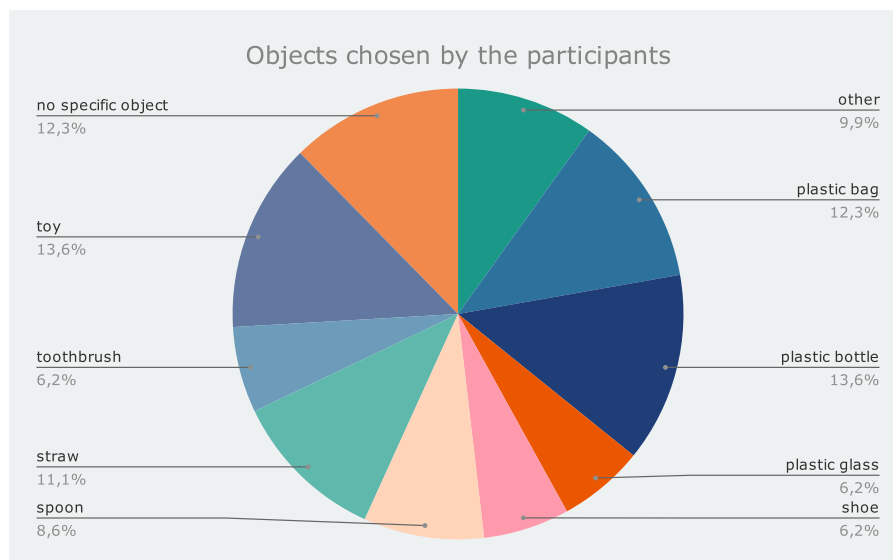
Fig. 2. Choice of objects by the participants. N = 81 stories, each with one object choice.

4.1. Perceived sources and pathways of MPL

The stories emphasized the diversity of factors leading to objects becoming litter, including natural elements and human behaviors, and the humanisation of objects having positive emotions as a product, often changing to negative once the objects became waste.

The pathways of MPL to enter the environment are diverse, which was reflected in the stories focusing on land and regional sources. A pattern emerged with most countries mentioned being in Latin America (only 11 stories mention other countries: three in the US, two in the UK, one in Japan, one in India, one in Malaysia and three in China). In terms of types of location for the story, the object as a product was often used on the beach (N = 21; 26 %) where it was sometimes disposed of (e.g. *The boy walked along the beach and when the juice ran out, he threw me* [the straw] *and the glass to the ground.*). Stories stressed that natural elements can cause the objects to end up in the sea (N = 38; 47 %). Among those natural elements, sea movement was the most recurrent (N = 19; 23 %) with ten participants (12 %) referring to the tide and eight to the waves (10 %). Other stories identified wind (N = 13; 16 %), rivers (N = 5; 6 %), animals (N = 5; 6 %) and rain (N = 4; 5 %) as contributing to the object becoming waste and entering the environment. This contrasts with fewer stories (N = 12; 15 %) that identified cultural factors (corresponding to human actions) as directly responsible for the object entering the sea. Among those human actions directly provoking the pollution, two stories from Ecuador mentioned trucks directly dropping waste into the ocean (e.g. *From this truck we were thrown off a very high cliff into the sea.*). Even if humans were not always depicted as directly responsible for littering, in more than half of the stories (N = 57; 70 %), the object nonetheless interacted with humans during its use as a product. The remaining stories often had a different focus (e.g. written from the perspective of marine fauna or from children participating in beach clean-ups who directly interact with the object as waste), and here little or no description of the object as a product was provided.

In the cases of human behavior leading directly and indirectly to plastic litter disposal, it was either explicitly noted in some stories as being intentional (N = 28; 35 %) (e.g. *The boy's father said it didn't matter, that he was going to buy him another toy later and he threw me into the sand as if I* [the toy] *were rubbish.*), or accidental (N = 26; 32 %) (e.g. *At that moment his sister called him to play and he didn't realize that in an oversight he had dropped the plastic spoon.*). For the few stories that described the emotions of the culprit (N = 23; 28 %), the main emotions were either thoughtlessness (not understanding the consequences of one's actions, e.

g. *Mariana didn't know the importance of throwing rubbish in the bin and without thinking twice she threw me* [the plastic spoon] *into the sea in a plastic bag with more rubbish.*) (N = 12; 15 %), guilt (feeling responsible for littering, e.g. *It was due to a human creation, to pollution. I felt terrible and sank into my pillow.*) (N = 7; 9 %) or indifference (explicitly not caring about the consequences of their actions, e.g. *My owner was disrespectful to the environment and left me* [the plastic bag] *stranded on a street.*) (N = 7; 9 %). Despite the diversity of factors considered in MPL entering the environment, a shared element was the journey of the object evident in 39 stories (48 %), with 34 stories (42 %) using a different location for the start and the end of the story. Only three stories (4 %) explicitly indicated that the object had not traveled.

In addition to the preference for certain objects, participants often chose to narrate in first person (N = 44; 54 %), mostly narrating as objects (N = 29; 36 %) instead of humans (N = 15; 19 %). Regardless of making the object the protagonist, they typically added human attributes to their chosen artifact such as thinking, talking or even emotions. Specifically, emotions associated with the object at the time of its use were largely positive (N = 21; 26 %); for example happiness, as opposed to negative emotions (N = 6; 7 %), such as sadness (Table 2). This contrasts sharply with emotions of the object as waste with only nine stories mentioning positive emotions (11 %), for example hope, compared to 21 stories (26 %) stressing negative emotions, such as powerlessness (Table 2).

4.2. Perceived impacts of MPL

Plastic pollution has a series of impacts on our environment and on societies. The stories described here stressed the harmful impacts on wildlife, particularly on fish and turtles, leading to environmental consequences, injuries, and eventually death, while the surveys also consider societal impacts (e.g. aesthetics of the beach).

When asked to consider the interactions of MPL with the environment, participants emphasize negative consequences such as the harm on wildlife. Overall, >50 % of stories show awareness of the harmful nature of plastics when interacting with wildlife in general with one or several types of interactions mentioned per story. Ingestion (N = 28; 35 %) was the most recurrent harmful interaction reported, followed by entanglement (N = 21; 26 %) and intoxication (N = 5; 6 %). Non-harmful interactions (N = 14; 12 %) could be discussions, i.e. open dialogues between the animal and the object (N = 8; 10 %), or overgrowth of marine fauna (biofouling) on the object (N = 7; 9 %) (Table 3). The

Table 2

Examples of emotion codes to understand the perceived sources of marine plastic litter. When the object has human characteristics such as thinking or talking, or is given a name, the code emotion enables us to infer an emotion that the object possesses as a product.

Code	Definition	Example
Positive emotion of product	The positive emotion of the object as a product identifies positive feelings either in the present (e.g. happiness) or picturing the future (excitement).	*The humans decided it was a good day to go out for a picnic on the beach, I was certainly excited, we were going to the beach, I was finally going to fulfill my role.*
Negative emotion of product	The negative emotion of the object as a product identifies negative feelings either in the present (e.g. sadness) or picturing the future (e.g. apprehensive).	*The brush had been living in a supermarket for a few months, anxious for someone to buy it, yet terrified of not knowing what would become of it when it was discarded.*
Positive emotion of waste	The positive emotion of the object as waste identifies positive feelings in the present (e.g. happiness) or picturing the future (e.g. hope)	*The spoon was very happy because it had been found and could be recycled.*
Negative emotion of waste	The negative emotion of the object as waste identifies negative feelings that relate to guilt, powerlessness or the awareness of being harmful.	*Poor turtle,* it *felt like* it *couldn't breathe. Jeff got caught in* its *throat and although he felt very bad about what was happening, there was nothing he could do about it.*

Table 3

Codes for the types of interactions (harmful and non-harmful) between fauna and plastic litter.

Code	Definition	Example
Ingestion	This code gathers the attempts, successful or not, from animals to eat the plastic.	*He approached the jellyfish so he could catch it, but when he caught it and was about to eat it, he noticed that it had a very strange taste and texture. -'What a strange jellyfish!' -said Juan and before he could try to swallow it, the jellyfish got stuck in his mouth. -'Get off, get off!' -said Juan. After a while, he was finally able to spit out the jellyfish, and what was his surprise when he saw what it really was - it was a plastic bag!*
Intoxication	This codes for animals being intoxicated by the components of plastic either by biting it or picking it up. It refers specifically to one story where an object is picked up by a dog that then gets a microbial infection.	*But it is possible that in the time the glass was there, it could have released toxins. The glass could have been eaten by an animal or perhaps an animal could have passed near the glass and breathed in the toxins that the glass was releasing and become sick.*
Entanglement	This codes for animals getting stuck in plastic or getting a plastic object stuck, making it impossible for them to move or function adequately. Examples of the stories include a tiny fish stuck in a bottle or a straw in a turtle's nose. It includes pieces of plastic being stuck onto or in the animal's body as long as the object being stuck is not a result of ingestion.	*Among the bags was a lone crab that could barely move as its legs and pincers were covered in the contaminating material.*
Discussion	As part of non-harmful interactions, this codes for dialogues between objects and animals. This can be about several topics.	*-'I'm not food, lady turtle!', I said, in a frightened tone. -'I'm sorry, Miss Bottle. It's just that I'm very hungry and my food has become scarce because of the pollution,' she replied.*
Overgrowth of marine fauna	Type of non-harmful interaction between animals and the object can include the growth of organisms, either micro or macro. Organisms that are visible are considered as macro whereas non visible organisms are considered as micro.	*But now I was becoming a new habitat for hydrozoans. These were tiny aggregates of the animal kingdom.*

stories particularly noted impacts on individual species with fish and turtles being the species mostly mentioned (N = 27 each; 33 %). This focus on turtles was evident through mentions of different impacts such as entanglement (e.g. *Unfortunately, one turtle ended up with its flipper stuck in one of the holes in the bag.*), ingestion (e.g. *One day I went to the beach and found a bottle bitten by a turtle. The turtle thought it was bait and ate it. I went back to the beach the next day and found the turtle dead.*) and their rescue (e.g. *Later a turtle also found a piece of plastic, but it got stuck in her mouth, that turtle managed to float to the beach of Bahía de Caráquez, where a group of people picked her up to try to help her.*). Such harmful interactions were also recorded for fish (e.g. *He* [the fish] *could not get out and every sudden movement he made caused cuts on his body and this caused him a lot of pain.*), along with non-harmful discussions, such as making new friendships (e.g. *Within a week Maria* [the fish] *got used to living inside me* [the bottle] *and I got used to her. Sometimes we talked when we were bored and kept each other company.*).

As a result of these interactions, the stories often described one or several consequences for the animal (N = 37; 46 %) including injuries (N = 10; 13 %), death (N = 16; 20 %), or an impact on its environment (N = 15; 19 %) (Table 4). The abundance of plastic pollution in the environment was noted in 27 stories highlighting that the object was not the only plastic out of place (e.g. *When the storm stopped, I* [the bottle] *saw many bags, shoes, glasses, brushes, straws, bottles and many other things that had also been swept away by the tide.*). Consequences for the object were also noted, including the loss of material properties (N = 22; 27 %) (e.g. *But it* [the plastic spoon] *was already broken, deteriorated and discolored from the unexpectedly long trip it had taken.*) and the transformation into microplastics (N = 5; 6 %) (e.g. *More than half of his* [the plastic bottle] *body turned into microplastics, which were scattered all over the Latin American coastline.*). The last step of an object's itinerary as waste could be a landfill (N = 8; 10 %), a recycling center (N = 9; 11 %), a rehabilitation center for animals saved from plastic pollution (N = 8; 10 %) or a laboratory where they were studied by scientists (N = 4; 5 %).

Whilst the impacts of MPL on wildlife were strongly emphasized in the stories, when directly asked about multiple impacts in the pre-post surveys, this was still seen as being important. However, the greatest impact was the effects of beach aesthetics. In the pre-survey, participants overall were aware of the multiple impacts MPL can have. They stated that MPL harms wildlife (4.43 ± 0.99) and enters the food chain

(4.25 ± 1.03), but they mostly emphasized that it affects the appearance of beaches (4.84 ± 0.56; mean ± standard deviation; scale from 1 to 5, with the highest values indicating full agreement). These levels of agreement did not change significantly with the activity and nor did the fact that they mostly emphasized beach aesthetics before impact on wildlife and the food chain ($p > 0.12$, see Appendix 8). Thus the surveys demonstrated that the participants were aware that MPL has multiple impacts, especially in terms of aesthetics, but the stories tended to focus on impacts on the wildlife.

4.3. Perceived solutions to MPL

When volunteering possible solutions to help address MPL, a focus was on preventative measures (stopping items from becoming MPL) rather than on reactive measures (cleaning up existing MPL). This was noted in both the stories and in the surveys with the most popular solution respectively being adequate disposal of litter and recycling.

Overall, 77 % (N = 62) of stories noted possible solution(s) to address

Table 4
Consequences of the interaction between fauna and plastic litter.

Code	Definition	Example
Animal's death	This codes for the interaction with the object resulting in the death of the animal.	*Tomás also told them that he had seen many animals that had died because of the plastic bags.*
Injuries	As a result of the interaction between the object and the animal, this codes for the object injuring the animal without it being a fatal injury.	*They had to take Manta to an exotic animal vet so that they could remove the straw from his mouth, which had injured Manta's palate and throat.*
Impact on the environment	This codes for the impact of the presence of the object on the animal's environment that does not cause injuries or death of the animals but that impacts their surroundings. It can be a lack of visibility due to the quantity of waste, etc.	*We all hope that one day we will be able to get out of the sea, because as far as we know we are making a lot of pollution.*

MPL, of which the majority (N = 42; 52 %) stressed preventive solutions. These were divided into: a) personal changes of behavior (N = 30; 37 %), either disposing of litter (N = 22; 27 %), recycling (N = 7; 9 %), reducing plastic use (N = 4; 5 %) or reusing plastic items (N = 1; 1 %), and b) social actions (N = 16; 20 %), such as education (N = 9; 11 %) and convincing the community of the importance of the issue (N = 6; 7 %). Some stories also included reactive solutions (N = 32; 40 %), proposing to pick up the litter (N = 20; 25 %), either by individual (N = 10; 12 %) or community (N = 10; 12 %) actions. Recycling the discarded waste was also mentioned (N = 6; 7 %) as a reactive solution, alongside the work of organizations arranging clean ups, for example (N = 10; 12 %), and the reuse of discarded objects (N = 4; 5 %) (Table 5).

Some stories mentioned recycling actions (N = 13; 16 %), either preventively (recycling plastic objects at home) or reactively (sending MPL items to recycling). Recycling was a popular solution in stories ranking just behind adequate disposal of rubbish (N = 22; 27 %) and picking up the waste (N = 20; 25 %). It should be noted that the code "recycling" was used for thematic analysis when participants used the word recycle (*reciclar* in Spanish). This term encompassed a variety of actions from industrial recycling (e.g. *They said that with a few tweaks I* [the toy wheel] *could be recycled and be in a new toy*), classifying waste at home (e.g. *Since then, she and her family have been trying to recycle as much as possible*) or even confused as re-use (e.g. *Making handcrafts from recyclables to put them to good use*), illustrating the use of recycling as a catch-all term.

The pre-survey indicated that participants were engaged from the beginning of the story-writing activity and willing to take action. Among the actions to prevent plastic litter from reaching the ocean, the most popular suggestion in the surveys was recycling (without further precision) (T1 = 26, T2 = 25) (Appendix 7). Other answers emphasized the importance of reducing plastic consumption to tackle the issue (T1 = 18; T2 = 16) while some other solutions seemed less popular. Education, for example, was only mentioned in nine stories (11 %), three times in pre-surveys (4 %) and once in post-surveys (1 %). Fines were suggested in one story (1 %), four times in the pre-survey (5 %) and three times in the post-survey (4 %).

4.4. Evaluating the activity

The surveys revealed important effects of participating in this story-writing activity. Participants claimed to significantly know more about MPL after doing the activity (3.64 ± 0.75) than before (3.50 ± 0.75, $Z = 2.20$, $p = 0.03$). In terms of perceptions, participants stated they were aware of the impacts plastic has, found it to be important to them, and were interested in learning more about the socio-environmental issues, but were less sure how their behaviors influenced MPL. These

Table 5
Codes for the types of solutions (RS = Reactive solution, PS = Preventive solution).

Code	Definition	Example
RS - Recycling	This codes for the recycling of waste, contrasting with recycling of products at home. This code refers to initiatives where the waste is recycled either by individuals or by groups.	*I learned that not only were there bottles that humans were leaving in the garbage cans for recycling, but they were also bringing in bottles that had previously been thrown into the sea.*
RS - Reuse	This codes for reuse of a littered object (hence a reactive solution) to be turned into another object by the person picking it up.	*I used it to make a small flowerpot and put a pretty flower in it, which now accompanies Susana.*
RS - Picking up the litter	This category refers to the litter inland or on the beach being picked up. It can be picked up either by individual actions or through community actions. It does not include any investigation of the litter, this will be coded under "work of organizations".	*Fortunately, a group of young people became aware of this huge problem and decided to create a team with the aim of collecting all this rubbish and changing the mentality of the population.*
RS - Waste processing	Litter being burnt (incinerated) or processed in a landfill.	*To them it all seemed so absurd as there was so much rubbish arriving every day and more than they burned, creating an endless cycle.*
RS - work of organizations	This code includes mentions of environmental groups, campaigns, or work like ReCiBa's that help picking up the litter and analyzing it.	*If there is anything positive about this, it is the campaigns that some organizations are campaigning against this kind of thing, working to help protect our planet.*
PS - social action	This codes for actions that depend on a third person rather than a personal change. This is subdivided into: education, politics, convince the community, convince the family and change of object design. This category will identify the changes needed as coming from above.	*The environmentalists put up signs all along the coast and, finally, called on the authorities to fine anyone who leaves plastic bags or plastic waste anywhere.*
PS - personal - change of attitude	This codes for encouraging a change of attitude to prevent litter from entering the ocean. It can either be deciding to recycle, to reuse objects, reduce consumption, to dispose properly.	*Sam and Paul no longer litter on the beach or anywhere else but in a recycling or reuse bin, understanding how important it is to CARE FOR OUR PLANET.*

perceptions were seen to be stable, and did not change between the start and the end of the activity ($p > 0.12$, see Appendix 8). Despite the participants having already stated that they were engaging in different PEBs such as recycling at home, encouraging others to behave more sustainably and picking up trash, all of these behaviors were found to significantly increase after engaging in this activity (Fig. 3; see Appendix 8 for full statistical analyses). Recycling remains the most popular PEB adopted (T1 and T2), confirming what had been found when participants were asked to name one action to avoid plastic litter from reaching the ocean.

The feedback questions indicate a positive impression of the schoolchildren towards this activity. All participants stated that they enjoyed the activity (range 3–5 out of 5), with the average response being 4.58 (± 0.57). Participants were very likely to recommend others to take part in the future (4.36 ± 1.00). They also agreed that they learned about the potential impacts of MPL by doing this activity (4.36 ± 0.82), what they could do about it (4.33 ± 0.85), and also that they had learned something new (4.31 ± 0.85).
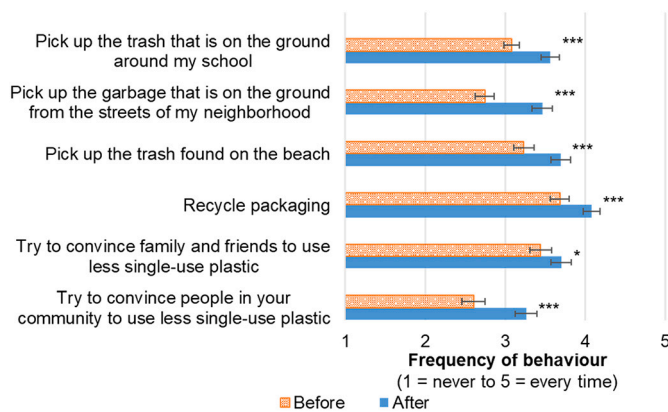
Fig. 3. Impact of the activity on pro-environmental behaviors. Bar chart shows average response (and standard error) to each behavior before and after the activity, all of which statistically improved over time (as indicated by *). Note. Difference was statistically significant at $p < 0.05$ *; $p < 0.01$ **; $p < 0.001$ ***.

5. Discussion

This paper examines an inclusive activity that schoolchildren in Latin America could remotely engage with during national lockdowns of the COVID-19 Pandemic. As well as assessing the activity as an engagement tool, the contents of the stories were examined to see what the children stressed in the object itineraries of MPL. Results indicate that participants have a good understanding of MPL sources being mostly terrestrial and local in the East Pacific and of the bio-ecological impacts of MPL, especially on emblematic and locally important animals. A diversity of solutions are presented in the stories while surveys tend to suggest recycling more often. In this section, we evaluate how perceptions of MPL sources, impacts and solutions compare to the scientific reality through the latest studies of MPL in the region and to other studies of adult and children perceptions. The efficacy of the method to engage participants and boost PEBs is assessed to unravel how stories could help to approach perceptions and motivate people to take action.

5.1. Perceived sources and pathways of MPL

The setup of most stories in LAC with their emphasis on local sources, from activities in natural environments (e.g. beach), is consistent with several environmental studies identifying that MPL mostly comes from land sources and is associated with recreational activities, such as tourism (Williams et al., 2016). The prominence of local terrestrial sources is attested on continental East Pacific beaches (e.g. Honorato-Zimmer et al., 2019; Gaibor et al., 2020; Garcés-Ordóñez et al., 2020b). While a variety of factors are being presented by participants, the stories often took place on the beach and beach littering, accidental or intentional, was a recurrent cause identified in our data. A similar trend was identified by Hartley et al. (2015) where children identified dropping litter as the main cause of plastic pollution and by Eastman et al. (2013) who found that many Chilean survey participants had admitted to have littered in the past. The stories were also consistent with a study by Wyles et al. (2016) that emphasized the assumed intentional nature in littering behaviors and disrespectful attitudes towards public litter when compared to fishing litter. The focus of this study on domestic (or public) MPL might have influenced how students wrote about these items. Yet, stories still reflect an awareness of the local context and identify (often intentional) littering behavior as one contributor to plastic pollution.

Among the most common types of objects chosen by the participants in the stories were plastic bottles and plastic bags. The importance of bottles and bags is consistent with these items being the third and fifth most common objects, respectively, found in beach clean-ups (Ocean

Conservancy, 2018). It indicates a close agreement between perceptions and recent data on MPL, particularly the short use-life of >60 % of macroplastics found on beaches in Colombia (Garcés-Ordóñez et al., 2020a), reflected in the stories by most objects being discarded after one day. This also corroborates negative emotions associated with single-use plastics (by definition having a very short use-life), linked to an awareness of their impact on the environment (Van Rensburg et al., 2020). Negative emotions associated with the objects as waste in the stories are consistent with perceptions of public litter found in previous studies compared to fishing litter (Wyles et al., 2016). This contrasts to positive emotions associated with the object in use (see Table 2). The type of litter presented to the students confirmed known perceptions of the objects and a focus on commonly found MPL items that are representative of plastic pollution.

In our study, participants wrote stories where children and teens were mostly the ones interacting with plastic, which might induce reflection about one's own behaviors and responsibility. This contrasts with the results of a survey by Hartley et al. (2018), which identified that some stakeholders including industries, retailers and governments are perceived as responsible for litter production and less motivated to solve the issue than respondents. It is noteworthy to say that, contrasting with other studies, the stories were not designed to assess children's comprehensive knowledge and perceptions about MPL. Participants may have been aware of these other contributors, yet chose elements that made a more engaging story or were easier to relate to (e.g. reflecting on their own experiences).

Focusing on one object and trying to identify the start of its itinerary led participants to think about everyday situations and behaviors related to the use and consumption of those domestic items that they could choose from. Participants also recognised the geographical journey that an item could undertake, truly exploring the dynamic concept of object itineraries. This framework also allowed them to reflect upon the ease and rapidity of the transition from product to waste while showing the diversity of pathways for an object to enter the environment.

5.2. Perceived impacts of MPL

The high awareness about the impacts of plastic pollution in this study confirms previous trends for schoolchildren identified in studies across the world (Heidbreder et al., 2019; Oturai et al., 2022; Wichmann et al., 2022). The survey responses demonstrated that the schoolchildren were aware of the multiple impacts (e.g. aesthetic consequences for people, impacts on wildlife and the potential risk to the marine food chain). However, it was through the stories that the children were able to emphasize and potentially dramatize these impacts and further demonstrate their understanding of them. A notable trend in these stories was that they focused primarily on bio-ecological impacts (on landscape and wildlife), which have also been perceived as more important in a study by Soares et al. (2021) of public perceptions from individuals aged between 18 and 69 years. While age and socio-cultural contexts might also influence those trends, there seems to be something more tangible and visible about bio-ecological impacts.

The bio-ecological impacts were highly prevalent but also diverse in the details provided in the stories. The awareness of impacts on marine wildlife was evident with harmful interactions appearing in more than half of the stories. This emphasis on wildlife could be a result of the story-writing process and the choice of more impactful and active scenarios. Both the orienting questions to create the stories ('How did the object interact with marine life?') and ReCiBa's previously published stories (*The sisterhood of the turtles*) might also have influenced participants to reflect on interactions with wildlife. Stories reveal awareness of potential harmful impacts of MPL beyond the impact on aesthetics stressed in the surveys. This aligns with schoolchildren's perceptions of MPL's impacts in the UK (Hartley et al., 2015) and with Chilean adults reporting to be "*absolutely aware*" of impacts of single-use plastic bags on the environment and on marine animals (Amenábar Cristi et al., 2020).

While the focus on bio-ecological impacts might have been influenced by the type of activity as part of ReCiBa and the instructions, it can also reflect a specific concern for these impacts on wildlife and landscape (as demonstrated by Soares et al., 2021).

When it comes to impacts on marine wildlife, there was a particular emphasis on fish and sea turtles in the stories. The focus on turtles could be understood given their emblematic status for raising awareness about the impacts of plastic pollution (Geary, 2019). As ReCiBa had published a book (cited above), the focus on turtles in the stories could also reflect familiarity with the book and turtles as threatened species in the region. Often participants note the entanglement of sea turtles, the ingestion of plastics and their eventual rescue. While elements about nesting are emphasized in ReCiBa's book, participants rather focused on the impact of plastic for the turtles at sea, sometimes discussing feelings of powerlessness of the object when hurting the turtle (see Table 2). Even though not as emblematic as turtles for the fight against plastic pollution, fish were mentioned equally as often in the stories and often described by the participants as suffering physically and emotionally from plastic pollution. The way fish were depicted by schoolchildren further contributes to results of a study by Rucinque et al. (2017) revealing that educated adults in Bogota and Curitiba generally perceive fish as sentient beings capable of feeling pain. While the level of education and regional context might influence those results, it seems that children also show this consideration, and almost empathy, through the content of their stories. This focus on fish could also be a result of the local socio-economic situation on the Pacific Coast where fish is an important and relatable resource for small- (Chuenpagdee et al., 2011; Chevallier et al., 2021) and large-scale fisheries (Martin et al., 2016). The focus on fish and turtles in stories might reflect their local importance and emblematic nature in the fight against plastic pollution, as well as familiarity with ReCiBa's publication. Greater empathy and relatedness to these animals due to their local importance could also have influenced participants to explore how MPL impacted them.

In brief, impacts were also explored in the stories as a part of the object itineraries: objects pass from one context (that of product) to another (that of waste) through a set of encounters (with animals and humans). Those interactions can leave marks on the objects, which inspired participants to explore how objects lost some of their material properties while considering the consequences of such unfortunate encounters.

5.3. Perceived solutions to MPL

Several solutions, reactive and preventive, to reduce plastic pollution were explored in the stories. An emphasis on preventive solutions contrasts with findings from Wichmann et al. (2022) identifying a focus on downstream solutions in surveys undertaken as part of a CS project. Among preventive solutions, proper disposal of litter appears to be the most popular in the stories, which has also been evidenced in Hartley et al.'s (2015) study of children's self-reported behavior to reduce litter. The most popular reactive solution in the stories was picking up the litter, which also appeared as a commonly adopted PEB after taking part in the activity. This corroborates findings of Locritani et al. (2019) who identified an increase of almost 70 % in the post-CS activity survey when participants (students aged 16–17 years old) indicated an inclination to pick up the litter.

The presented solutions are shaped by a series of factors, such as age. Notably, litter-picking behaviors with younger students showed a drop after the CS activity while older students have a more stable attitude (Oturai et al., 2022). In that perspective, Eastman et al. (2013) identified a preference for environmental education followed by the implementation of fines in a study of adult beach users' attitudes towards littering. While stories emphasize the importance of education at the same level as recycling (both as preventive and reactive solutions), the implementation of fines was barely suggested in stories and surveys. Little emphasis on this type of solution might be related to the

complexity of the issue with limitations for plastic use depending on national and subnational legislations (Ortiz et al., 2020). With plastic pollution being an increased threat to LAC beaches after the COVID-19 Pandemic (Alfonso et al., 2021), there is hope for more uniformity on the matter, from regulatory policies to information instruments, thanks to the recent Pacific Alliance (Ortiz et al., 2020) and the forthcoming UN Global Plasics Treaty where Ecuador and Peru will represent LAC and the Caribbean. This difference in proposed solutions might reflect different beliefs and acceptance due to demographics and local context, as well as different roles and capacity of action within the household.

A solution that appears in both reactive and preventive categories was recycling. If recycling is considered as both household waste classification and at an industrial scale, the use of this term appeared as the third most popular suggestion in the stories and the most popular in the surveys. While this focus on recycling as the chosen action to prevent plastic litter from reaching the ocean in surveys might result from the need to give 'expected' answers, the mention of recycling in stories seems to indicate a confusion as to what it actually encompasses. It further illustrates the use of recycling (*reciclar*) as a catch-all term to discuss both waste classification and industrial recycling of plastics into new materials. This confusion about what recycling is (Alexander et al., 2009) adds to uncertainties regarding how to adopt this behavior at home (Burgess et al., 2021).

This focus on recycling could also be related to a regional educational discourse favoring the three Rs (Reduce, Reuse, Recycle). For example, some educational projects in LAC even present Coca Cola as an environmentally-responsible company that practices recycling (in Pelaez and Hernández, 2019). But in practice, the LAC region industrially recycles only 4.5 % of its waste (Brooks et al., 2020). While this rate does not account for informal practices of recycling (or scavenging) (Brooks et al., 2020; Medina, 2015), our data could reflect the local importance of informal recycling practices. While it fits with a regional discourse, the focus on recycling suggests confusion regarding its meaning and could suggest the importance of informal practices not reflected by regional recycling rates.

After inspiring participants to track the origins of the objects and evaluate their impacts, the objects here served as a basis to envision solutions, from plastic production to waste management. While the activity was not designed to present participants with a review of available solutions, they considered them in the stories. Thinking of a specific object, and narrating its itinerary, offers a way to think about solutions in a more creative and diverse way than surveys, given that several solutions were often mentioned in one story.

5.4. Story writing for engagement and PEBs

The activity of story writing has two main contributions: an increase of self-assessed knowledge on the topic of plastic pollution and an impact on PEBs. Similarly to outcomes of CS projects (e.g. Locritani et al., 2019) and beach clean-ups (e.g. Owens, 2018; Veiga et al., 2016), the story-writing activity led to an increase in self-assessed knowledge about plastic pollution. With all PEBs reported to significantly increase after the story-writing activity, those results seem to align with benefits of beach clean-up activities (e.g. Wyles et al., 2017; Owens, 2018) and education initiatives (e.g. Hartley et al., 2015). Yet, all initiatives do not impact PEBs equally. For example, Oturai et al. (2022) demonstrated that the CS activity *The Mass Experiment* did not impact PEBs significantly. A series of factors might explain differences with our study such as the local context (Denmark vs LAC), the type of activity (CS vs story writing), the survey design (PEBs occurring in the previous week vs occurrence of PEBs from never to always) and the age of participants. Story writing might have helped participants to think more deeply about the impacts of human behavior and the importance of PEBs to address the issue of MPL. Notably, age has been demonstrated to impact PEBs with older students showing more stability in their adoption (Oturai et al., 2022), which could be reflected in the age category of our sample.

Another study yielded similar results with no significant change in PEBs of Chilean students participating in a beach-sampling CS project (Wichmann et al., 2022). Wichmann et al. (2022) also suggested that a direct consideration of human behavior in any project might be essential to boost PEBs, corroborating previous studies (e.g. Baur and Haase, 2013).

Mechanisms of story writing, analyzing the journey of an object interacting with a series of actors to create the story, offer participants a more in-depth consideration of human behaviors in the object itinerary. Besides, agreeing to share their stories on the website provides another layer to the reflection on one's behaviors and actions, rendering them visible by other participants and the general public. But story writing also implies making choices about what constitutes a better story and therefore the stories allow us to explore perceptions (not necessarily in a comprehensive way) rather than being a direct assessment of participants' knowledge on the topic (see Gibson, 1986, Cassam, 2008, Brewer, 2011 for discussions on perception and knowledge). By accepting the gap between perceptions, intentions, and (self-reported) behaviors, we still recognise the potential of the activity as a more organic exploratory tool to engage schoolchildren with the topic and boost PEBs. While our much smaller sample size might also play a role in those positive PEB results, future studies should assess if story writing is confirmed as an efficient tool to boost PEBs.

There is a diversity of PEBs that can be adopted, and the activity seems to have particularly boosted recycling (waste classification), which was the most commonly adopted behavior before and after the activity, as well as the most recurrent action suggested in surveys. The emphasis on recycling in the surveys might be a result of it being a popular solution in the region and a commonly self-reported behavior, especially among schoolchildren. High self-reports of recycling (varying regionally between 40 % and 82 % of respondents between the age of 16 and 77) have been identified by Kiessling et al. (2017) along the Pacific Coast, suggesting a regional belief in the solution. With the method of self-report prone to overestimates (Chao et al., 2021) and not directly reflecting recycling behavior (Kiessling et al., 2017), our data, self-reported behaviors from schoolchildren, contrasts with lower local recycling rates and could be typical for the audience of this study. Schoolchildren are indeed particularly fond of this solution, as evidenced by Salazar et al. (2022) who found that children were 11 % more likely to mention recycling actions than their parents. The preference for this solution by schoolchildren could be understood further through two elements known to impact (self-reported) recycling behavior: their higher institutional trust (Harring et al., 2019), and their environmental awareness and concern (Chao et al., 2021). Our data also indicate a confusion to what recycling actually refers to, leading participants to use this catch-all term to refer to industrial recycling and waste classification at home. Other boosted PEBs in our surveys include litter-picking behaviors more likely to be adopted on beaches than in participants' neighborhoods. This difference might reflect a specific concern for the natural environment, already identified by Wyles et al. (2017) in beach clean-ups, and corroborates findings of children's litter blindness in urban areas compared to natural environments demonstrated by De Veer et al. (2022). A different focus on solutions such as recycling and litter picking in natural environments can be better understood by considering the particularities of schoolchildren as participants of this study.

The story-writing activity can therefore be considered as a good engagement tool that enhances a series of PEBs along with being an enjoyable and recommendable experience. Story writing, an inclusive exercise easily adopted in times of uncertainties, has been shown to be an interesting method to explore perceptions of MPL as artifacts and engage schoolchildren to reconstruct object itineraries. The activity was designed to allow participants to grasp and reflect upon the complexity of a plastic object itinerary, evidencing the links with different actors and their behaviors rather than providing a way of learning about different solutions to plastic pollution. While this study offered a window into participants' perceptions, future work could explore how those perceptions developed by identifying common sources of information in the region regarding sources and impacts of MPL and the available solutions. With participants coming from different countries and socio-economic contexts, it was beyond the scope to provide students with further recommendations for solutions to MPL. There is, however, scope for further studies to include the latter and to compare the perceptions from other demographic groups or in other contexts, for example oceanic islands characterized by non-local sources of MPL (e.g. Thiel et al., 2021). A similar study including more industrial items (such as fishing litter) could also explore how these are perceived and contribute to literature on the different attitudes towards fishing and public litter (e.g. Wyles et al., 2016), the latter being the topic of this study.

6. Conclusion

In addition to the story-writing activity being a good tool to increase self-assessed knowledge of MPL and boost PEBs, our data suggest a good understanding of beach litter's sources and impacts by schoolchildren on the East Pacific Coast participating in the program. In comparison, the diversity of solutions was fully explored in stories, showing a preference for preventive solutions, but was dominated by recycling in surveys (suggested actions and PEBs).

Sources of MPL, mostly the result of human behaviors, were well identified in the stories and surveys, and reflect a good grasp of the topic's latest studies in the region. The diversity of pathways for litter to enter the ocean evoked in stories reflect the different sources including recreational activities and coincides with most MPL in the region coming from local land sources. The schoolchildrens' choice of objects reflects an awareness of the types of MPL items commonly found on the beach, such as plastic bags and bottles. Participants were mostly aware of bio-ecological impacts of MPL on the landscape (in surveys) and the wildlife (in stories). Harmful interactions are recurrent in the stories, showing an understanding of the impacts of MPL on wildlife. The choice of fish and turtle reflect their respective local importance and the turtle's emblematic nature as protagonist of ReCiBa's tale "The sisterhood of the turtles".

With recycling as the most popular solution in the surveys, we argue that our survey data might reflect the efficiency of the 'recycling myth' where recycling is the ideal solution presented by industries, governments and even by consumers (Buffington, 2015). It also confirms the belief put into recycling as a solution even when participants do not refer to the same behavior highlighting the confusion with the term. Stories offered more flexibility to schoolchildren not repeating expected answers as they mostly emphasized preventive solutions with proper disposal of litter first. The diversity of solutions across the stories and their non-exclusive consideration by schoolchildren illustrate a good grasp of the potential of recycling as a complementary solution only while shifting our economy away from consumerism and disposability.

In conclusion, the story-writing activity has been shown to be both a valuable engagement tool efficient to increase PEBs amidst the COVID-19 Pandemic and a method to gather complementary data to explore perceptions of MPL's sources, impacts and solutions. While messages in glass bottles once floated on ocean currents, carrying with them the hopes of their senders that help may one day arrive, those same currents now carry plastic waste, much of it in the form of plastic bottles (Ryan et al., 2019, 2021). In this paper we have shown how those plastic bottles themselves, alongside all other plastic waste, continue to carry messages not so far removed from the ones sent by stranded sailors: that help is urgently needed. This paper has shown that children also understand this message but that more work is needed to help them evaluate the solutions.

Ethical consent

Parental and schoolchildren consents were asked for survey analysis, stories analysis and to share stories on the Zenodo website https://doi.org/10.5281/zenodo.7411595. The project was reviewed and approved by the Scientific Ethics Committee of Universidad Católica del Norte (CEC UCN n°16/2020).

CRediT authorship contribution statement

Estelle Praet: Methodology, Formal analysis, Visualization, Writing – original draft, Data curation, Writing – review & editing. **Jostein Baeza-Álvarez:** Methodology, Visualization, Writing – review & editing. **Diamela De Veer:** Conceptualization, Investigation, Resources, Writing – review & editing, Data curation. **Geraldine Holtmann-Ahumada:** Project administration, Investigation, Data curation. **Jen S. Jones:** Conceptualization, Writing – review & editing. **Sarah Langford:** Conceptualization. **Jessica Michel Dearte:** Conceptualization, Resources. **John Schofield:** Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Martin Thiel:** Conceptualization, Investigation, Resources, Project administration, Writing – original draft, Writing – review & editing. **Kayleigh J. Wyles:** Conceptualization, Methodology, Formal analysis, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpolbul.2022.114457.

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