Tell a Story to Save a River: Assessing the Impact of Using a Children's Book in the Classroom as a Tool to Promote Environmental Awareness

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Listening to a story stimulates children to understand concepts and vocabulary, while developing their background knowledge. Previous research indicates that the use of scientifically accurate literature helps children connect to the natural world. Promoting environmental education (EE) should be of utmost importance in school curricula, providing opportunities to students to improve their knowledge regarding the environment, and how to protect it. Particularly, marine ecosystems have been subject to increasing pressures, highlighting the importance of taking Ocean Literacy (OL) to the classroom. Drawing attention to more relatable environments, like a river, by tailoring OL activities to local contexts and community interests, might be an efficient strategy to raise awareness of ocean problems. A children's book, written by a MARE (Marine and Environmental Sciences Centre, Portugal) researcher, with a macrobenthic invertebrate as the main character, was the springboard for an outreach project, developed with elementary school students. The project aimed to assess the impact of using a children's book as a tool to promote environmental awareness, focusing on river basin ecological issues. Researchers conducted reading sessions of the book with 89 female and 87 male elementary school students (ages between 8–10). The target audience were students from two public and two private schools from an urban city and a city with a strong fishing tradition, aiming to assess if the reading session impacted students differently according to their background. A sequential explanatory mixed methodology was applied, using a pretest-posttest design, combined with focus group interviews in the last phase, to measure change in students' knowledge, before and after the reading. Results demonstrated that there was an overall improvement in students' knowledge regarding river basin biodiversity and anthropogenic threats they are subjected to.

Furthermore, the idea that local impacts on rivers will also reach and influence the ocean was always present throughout the reading sessions. Students' background, such as the type of school and region influenced higher posttest score results. In particular, students from Lisbon had higher scores in posttest results, while the same was observed for students from private schools. The present research revealed that a children's book is an effective tool to improve environmental knowledge, while being an entertaining activity for students.

INTRODUCTION

Our society relies on limited resources that are being overused and neglected, jeopardizing not only nature but human health and global prosperity (Muthukrishnan, 2019). It is urgent to educate and inform citizens of all ages, promoting responsible attitudes, and a critical mindset. Stapp et al. (1969), the first to coin the term environmental education (EE), defined its goal as "(. . .) producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution." EE should be accessible to all, providing opportunities for every citizen to improve their knowledge regarding the natural world, and the ways to protect it, engaging society to contribute in its protection (UNESCO-UNEP, 1978). This should be a subject of utmost importance in school curricula, not only because students of today are the citizens of the future, but also because they can be influential vectors, through whom the environmental message reaches a wider audience, since it is passed on to their relatives (Ballantyne et al., 1998).

Marine ecosystems have been subject to increasing pressures, accentuating the need to raise awareness on their environmental problems, through the advocacy of a more ocean literate society. The goals of EE are aligned with the ones of Ocean Literacy (OL): according to the US Commission on Ocean Policy [USCOP], 2004, to be considered an ocean-literate person, besides understanding the ocean, one should be able to communicate about it and to make informed and responsible decisions regarding its resources (Cava et al., 2005), understanding how dependent we all are on the marine ecosystems, and how those depend on our attitudes [National Oceanic and Atmospheric Administration [NOAA], 2013]. Highlighting the importance of taking the ocean to the classrooms, in 2015 the United Nations announced the Agenda 2030 for Sustainable Development, composed of 17 Sustainable Development Goals (SDGs), one of which, the SDG 14 is: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" [UNESCO, 2017]. More recently, it was declared the United Nations Decade of Ocean Science for Sustainable Development 2021–2030, demanding increasing efforts to implement OL activities [United Nations [UN], 2018]. Promoting awareness on ocean issues while strengthening society's connection to the ocean is fundamental, considering most citizens across different countries have deficient knowledge of ocean concepts and the

way marine ecosystems affect their life quality (Schoedinger et al., 2006; Guest et al., 2015; Mogias et al., 2019).

Drawing attention to more relatable environments, tailoring OL activities to local contexts and community interests, might be an efficient strategy to raise awareness on ocean problems (Kelly et al., 2021). As stated in the "OL Essential Principles and Fundamental Concepts," principle 1.g. and 6.e. (Ocean Literacy Campaign, 2013), all the water in the planet is somehow united to the ocean, and pollution and physical modifications in inland ecosystems, like rivers, affect the ocean. Promoting awareness for inland waters, like river's protection, can be a path for the promotion of OL.

A scientifically accurate children's book is an accessible tool to deliver knowledge in a delightful way (Pringle and Lamme, 2005), allowing young readers to understand abstract concepts that become more relatable (Carr et al., 2001). By immersing in the plot of the story, children relate with the characters' emotions, making connections that inspire them to find solutions to problems that gain a more empathetic perspective (Butzow and Butzow, 1990; Monhardt and Monhardt, 2000; Zambo, 2007). Besides knowledge improvement, using a storybook to teach scientific concepts often contributes to gain respect, caring, and concern for nature (Moser, 1994) fundamental values to embrace environmental protection.

When choosing a storybook to teach science, attention to accuracy should be a priority, since students will assume that the information they hear in the classroom is correct, thus, without dismissing writers' creativity, the text must contain precise scientific concepts (Rice, 2002; Pringle and Lamme, 2005). Furthermore, communicating to the public is often a challenge for many researchers, despite being a crucial part of their work, and storytelling can be a valuable outreach tool (Martinez-Conde and Macknik, 2017).

In the present study, a children's book, an original short story written by a MARE (Marine and Environmental Sciences Centre, Portugal) researcher, with a macrobenthic invertebrate as the charismatic main character (a water scorpion), was the springboard for an outreach project. Reading sessions of the book by Chaves (2018) *Zé, the false scorpion* ("*Zé, o falso escorpião*") were carried out with elementary school students from private and public schools located at the Portuguese cities: Lisbon, a more urbanized city and Setúbal, a city with a strong fishing heritage. The project aimed to assess the impact of using a children's book as a tool to promote environmental awareness, focusing on

river basin ecological issues. Another objective was to understand how student's background (different cities and different types of school) influences knowledge improvement, given the use of the referred tool. Overall, we expect to further contribute to a more ecologically educated and ocean-literate society.

MATERIALS AND METHODS

The project was presented to the schools' coordinators and teachers, to grant permissions and establish contacts. A total of 176 elementary school students participated in the project (89 female and 87 male), comprising eight classes from grades 3 and 4 (aged 8–10). The students belonged to four different schools: one private and one public school, respectively, from an urban city (Lisbon) and from a city with a strong fishing heritage (Setúbal).

Activities included two visits to each school, carried out by MARE researchers, belonging to the educational outreach program "MARE goes to school." The first visit, performed always by the same person, to avoid variances across the read-aloud, consisted of a reading session of the book "Zé, the false scorpion" ("*Zé, o falso escorpião*"). In the story, a boy is enjoying a walk by a river when encounters a water scorpion. Curious, the boy wants to know more about it, and it is the water scorpion that explains all about its anatomy and ecology, and human impacts on the river (water pollution, sand extraction, plants destruction and the construction of bridges and dams). Deciding to help preserve the river, the boy spreads the message and manages to get the attention of grownups that build a fishway to mitigate the dam impact. In the end, the reader is encouraged to visit a river and learn more about it. During the session, students were stimulated to interact, by asking questions, or commenting on the story. Book illustrations were displayed through a data-show system, so students could observe them while listening, for a better comprehension of the mentioned concepts. Two and a half weeks later, the second visit consisted of collecting data to assess the book effect on students, and was carried out by the person of the first visit, with the assistance of another co-author of the present study (MARE researcher). Sessions were performed inside the classroom, during school-time, and the teachers were always present.

Data Collection

To investigate the effect of the reading on students' knowledge, a sequential explanatory mixed methodology was applied, with a pretest-posttest design, combined with focus group sessions in the last phase. The following assessment instruments were used:

(i) A pretest closed questionnaire (**Table 1**), comprising seven questions related to rivers biodiversity and the anthropogenic impacts they are subjected to, aiming to evaluate students' previous knowledge of the issues focused in the subsequent reading session;

(ii) A posttest consisting of the same questionnaires used as pretest (**Table 1**) was applied on the last visit to the school, to compare change in students' knowledge before and after the reading;

TABLE 1 | List of questions used as pretest and posttest.

Question

1. Knowledge on rivers' biodiversity

1.1. Identify all the animals that can be found in rivers
   a. Killer Whales
   b. **Fishes**
   c. **Insects**
   d. Anemones
   e. Corals

1.2. To which group of animals belongs the water scorpion?
   a. **Insects**
   b. Crustaceans
   c. Mollusks
   d. Amphibians
   e. Mammals

1.3. What distinguishes insects from other animals?
   a. **Lay eggs, metamorphize, molt the external skeleton, have six legs**
   b. Can't metamorphize, have scales, have an internal skeleton, have four legs
   c. Have fur, produce milk for their young through mammary glands, females get pregnant, the skeleton grows
   d. Have feathers, lay eggs, the skeleton grows, have two legs

2. Threats to river's biodiversity

2.1. Identify all the examples of threats to river's biodiversity:
   a. **Water pollution**
   b. **Dams**
   c. Air pollution
   d. Wind turbine towers
   e. Native forest conservation

2.2. Identify one problem caused by dams to rivers' biodiversity:
   a. **Block the passage through the river**
   b. Water gets saltier
   c. Damage coral reefs
   d. Reduce seals' population
   e. Increase water clearness

3. Rivers' Conservation

3.1. Identify all that can be done to protect rivers' biodiversity:
   a. **Reach to an environmental organization when there is a threat**
   b. **Build a fish ladder**
   c. Organize a music festival by the river
   d. Feed the animals that live on the river
   e. Cut vegetation from the margins

4. Uses of rivers

4.1. From the examples, choose all that better fit the next sentence, "Rivers are important for people, to":
   a. **Produce energy**
   b. **Water the fields**
   c. Observe whales and sharks
   d. Extract oil
   e. Produce seaweed

Correct answers are indicated in bold.

(iii) A focus group session was conducted with each class, after the posttest was applied. The session had a duration of 15 min and it was held with each class divided in two groups, which participated separately in the session. The moderator facilitated the discussion using eight pre-determined questions (**Table 2**), allowing students to offer contributions on what they believed was the main message of the story and their appreciation of the book. This instrument supports the findings from

Question
1. What kind of river animals do you know?
2. In the story, which animal is the main character? What distinguishes it from other animals?
3. What does António [character from the story] find about the threats rivers are facing?
4. How does António try to solve the problem?
5. Why is it important to protect rivers and their biodiversity?
6. What can we do to protect them?
7. What would you like to add about the questionnaire (posttest) you filled today?
8. And finally, what did you like the most? And the least?

the other questionnaires, enabling a methodological triangulation approach. To ensure that none of the student's interventions was missed, focus group sessions were audio-recorded;

(iv) Satisfaction questionnaires (**Supplementary Appendix 1**), composed of nine questions with answers varying in a Likert scale from 1 to 5 (1 – Nothing; 2 – Not much; 3 – More or less; 4 – Very; 5 – A lot), and two "open questions" ("What did you like the most? And the least?") were applied after the reading session, to assess students' appreciation of the book.

Data Analysis
Pre and Posttest
Answers obtained from both questionnaires (pre and post) were scored according to a correction matrix (Mogias et al., 2019): each correct answer from both questionnaires had a score equal to one (1); on multiple-choice questions the score value was divided by the number of correct options; each incorrect answer was scored as zero (0); the total score obtained was considered proportional to students' knowledge on the subjects.

Students' answers to each question in pre and post questionnaires were also transformed in relative frequencies. To compare these relative frequencies between pre and posttests, a t-test statistic (t) was used and if greater than 1.97 a statistically significant difference was considered.

Considering that score data were not normal, the non-parametric Kruskal–Wallis (H) test was applied to analyze the existence of statistically significant differences ($p < 0.05$). Applying the same method, posttest results were further analyzed, to assess the effects of schools' background factors (region and public/private) on students' knowledge. Analyses were performed in R software (R Core Team, 2019).

Focus Group
All focus group interviews were audio-recorded and were analyzed through content analysis, based on categories that emerged from starting questions and responses given by the participants, aiming to support the study results. Through an iterative process of reading and re-reading data, meaningful

pieces of text were assigned to those categories (Miles and Huberman, 1994).

Appreciation Survey
Answers to the appreciation questionnaires were subject to descriptive statistics based on their relative percentages.

RESULTS

Knowledge and Environmental Awareness
Students revealed an overall improvement of knowledge on the issues presented in the story, obtaining significant statistical differences between the scores, in pre and posttests ($H = 10.854$, $p < 0.05$), with higher average scores in posttest questionnaires (**Figure 1**).

Significant statistical differences between pre and posttests were obtained across most of the questions, with exception to the questions: 1.1. E, 1.2. C and D, 2.1. A and E and 2.2. D ($t < 1.97$) (**Figure 2**). The highest change in perception was registered on the following issues: the correct classification of the water scorpion as an insect (1.2. A and 1.2. E), the perception of dams as a threat to river biodiversity (2.1. B), and the realization that feeding the animals is not a solution to protect river fauna (3.1. D) (**Figure 2**). These results were validated during the focus group sessions. The aspects of the story better retained by the students were related to the main character, human impacts and the appropriate solutions:

> Zé was a water scorpion, a bug! (Student 1).
> It had a tube to breathe above the water (Student 2).
> It is different from the other scorpion, because its tail does not sting (Student 3).
> The river was polluted because humans were polluting it, and there was a dam blocking animals' passage to the other side of the river (Student 4).
> In the end they built a ladder to help the fishes (Student 5).

Influence of Students' Background Factors
From the 176 students that took part in the project, 57.4% were from private schools, and 42.4% from public schools. Results revealed a statistically significant difference between public and private schools, regarding posttest's scores. Students from private schools had higher average scores in posttests. ($H = 10.854$, $p < 0.05$) (**Figure 3**).

Regarding school location, students from Lisbon represented 57.4% of the total sample, and students from Setúbal represented 42.6%. Differences in posttest scores between students from Lisbon (urban area) and Setúbal (fishing area) were statistically significant ($H = 10.854$, $p < 0.05$). Higher average scores in posttests were obtained for Lisbon students (**Figure 4**).

Appreciation Survey
The overall students' evaluation of the story was very positive (4 – 34%; 5 – 58%) (**Table 3**). Regarding illustrations, opinions were
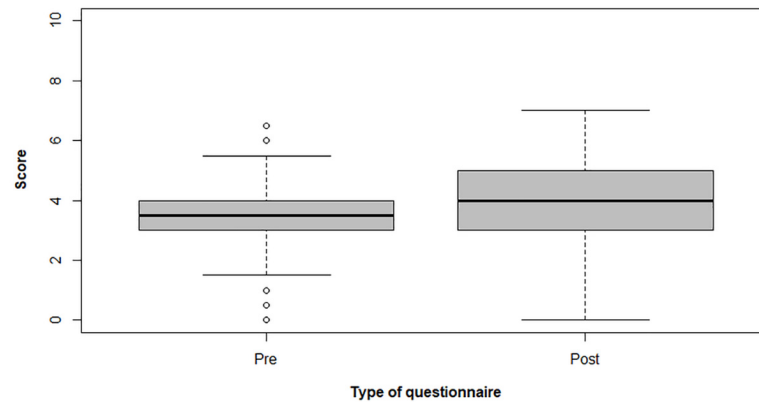
FIGURE 1 | Total scores for each type of questionnaire (Middle line – median; box lower and upper limits – 1st and 3rd quantiles; whisker values – 1.5 times the interquartile range from the top (or bottom) of the box to the furthest datum; points – outliers).
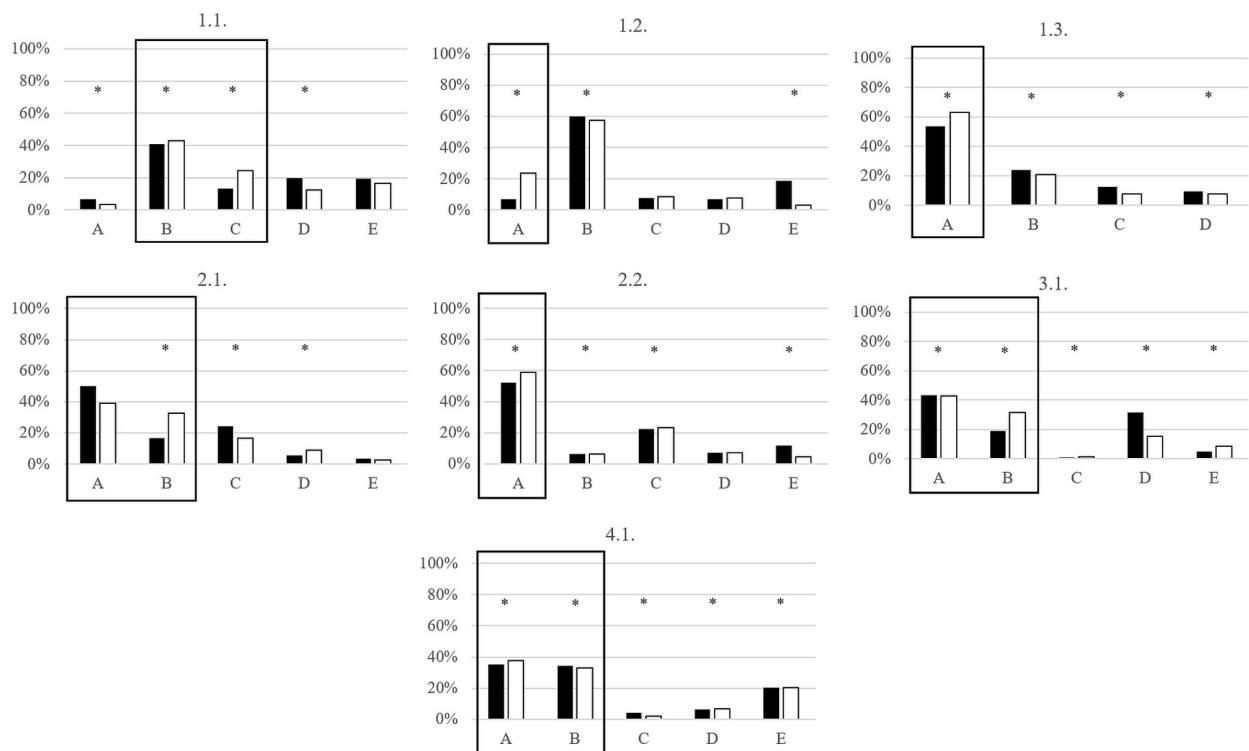
FIGURE 2 | Relative frequencies obtained for each question: ■ pretest; □ posttest. Questions with significant differences between pre and posttests are marked with * (Correct answers are marked with a rectangle).

also positive (4 – 25%; 5 – 41%). Most found the story informative (5 – 72%), "easy to understand" (5 – 62%) and interesting (5 – 54%). Students indicated that the story contributed to raise their awareness of river conservation (5 – 69%) and helped them to understand human impacts on rivers. One of the most liked aspects referred to in the open answers, besides the story (11.9%) and the main character (10.2%), was "helping the animals/the river" (7.4%), and one of the least liked was "river pollution" (9%).

Results from the appreciation questionnaires were consistent with students' opinions expressed during the focus group sessions, when they highlighted the following aspects of the story:

I liked that they [story characters] contributed to save the river (Student 6).
I liked that they helped the river to get better (Student 7).
What I liked the most was that they built a passage for the fishes (Student 8).
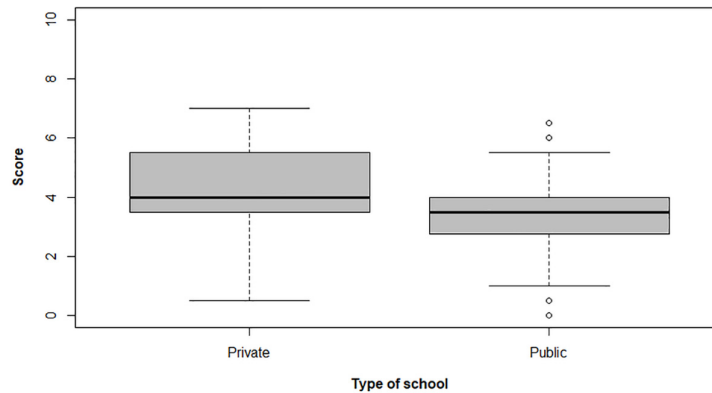
FIGURE 3 | Posttest scores considering the type of school (private and public) [Middle line – median; box lower and upper limits – 1st and 3rd quantiles; whisker values – 1.5 times the interquartile range from the top (or bottom) of the box to the furthest datum; points – outliers].
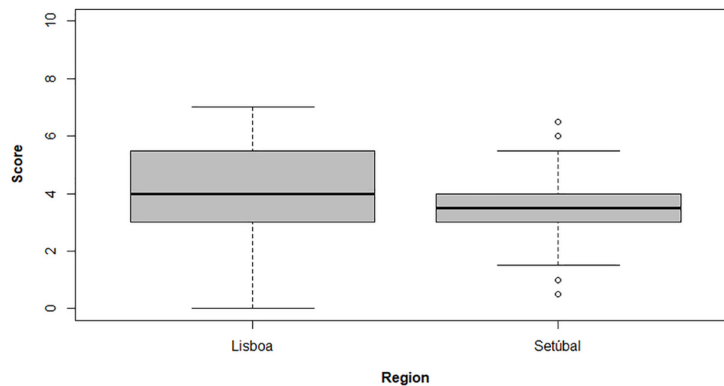
FIGURE 4 | Posttest scores considering school region [Middle line – median; box lower and upper limits – 1st and 3rd quantiles; whisker values – 1.5 times the interquartile range from the top (or bottom) of the box to the furthest datum; points – outliers].

I enjoyed the story, because it was original, and about an animal (Student 9).

While the aspects they most disliked were:

I did not like that the river was polluted (Student 10).

I did not like when they were polluting, and Zé was sad (Student 11).

I did not like that they built dams on rivers (Student 12).

Overall, these results showed a knowledge improvement on the environmental concepts presented in the story as well as a positive perception of the book among the majority of students.

DISCUSSION

Knowledge and Environmental Awareness

Results obtained showed a significant knowledge improvement of environmental concepts related to river basin ecological issues, after the reading session. This reveals that listening to a story contributes to understanding concepts and is coherent with previous studies that demonstrated how stories about nature that incorporate science concepts contribute to a better comprehension of ecological issues (Dowd, 1991). Furthermore, Rice (2002) has also shown that a plot helps children to

TABLE 3 | Answers (%) from the appreciation questionnaires.

Question	1	2	3	4	5
Did you like the story?	-	1	8	34	58
Did you like the illustrations?	4	5	25	25	41
Overall, did you find the story:					
Fun	-	7	14	30	48
Informative	-	1	5	22	72
Interesting	2	5	14	24	54
Easy to understand	1	3	11	23	62
How did the story contributed to:					
Improve your knowledge on river biodiversity	1	3	6	29	60
Raise your awareness on the need to protect rivers	1	2	6	22	69
Understand human impacts on rivers	1	2	8	26	62

n = 176. Likert scale: 1, nothing; 2, not much; 3, more or less; 4, very; 5, a lot.

better remember and comprehend concepts than facts presented in a textbook. Kaser (2001) demonstrated how stories widen children's knowledge and imagination, by awakening their intrinsic curiosity.

From the comparison of the relative frequencies of the answers in pre and posttests, no significant statistical differences were found on the questions related to aspects students are already familiar with, for example, that the water scorpion could not be a mollusk or an amphibian, or that water pollution is a threat to river biodiversity. Contrarily, questions that revealed a more accentuated change in perception elucidate elements of the story better retained by students: main character aspects (water scorpion being an insect), anthropogenic threats to its habitat (more specifically dams), and the most appropriate measures to solve, mitigate or prevent their impacts. When children listen to a story, they relate to the characters' problems, making connections with their feelings and emotions, in such a way that book characters often become friends and teachers (Zambo, 2007). In a project described by Monhardt and Monhardt (2000), where children's books were used to examine environmental beliefs and attitudes of sixth graders, it was demonstrated that most of the students identified with the environmentalist cause debated in the story, feeling empathy for the main character (an endangered species that broke into someone's house). Nonetheless, authors warn for the children's emotional connection with characters often being stronger than the development of critical thinking skills. Since they might become biased for a particular perspective, based on emotions rather than on scientific concepts, researchers suggest caution when addressing ecologic controversial issues. This might be surpassed with a group discussion after the reading, when different perspectives can be debated and a deeper critical understanding of the story should be promoted, encouraging children to reflect on the issues addressed (Baumann and Duffy, 1997). The inclusion of critical questions to be discussed in scientifically sound children's books, would also be an important tool to promote this debate. In the present study, students' interventions during focus group sessions were consistent with the posttests' results, highlighting their interest and curiosity about the main character, and their concern on the threats that put its life in danger, while it was clear that they remembered the appropriate solutions to the environmental problems addressed. Regarding the anthropogenic threats, there was a clear improvement in the perception about the impacts caused by dams, but also their relevance for the community and how the impact might be mitigated. In the story, the construction of a dam represents an obstacle for the main character (water scorpion) and other animals, and the solution found (a fishway) contributes to the happy ending (Chaves, 2018).

Understanding how physical modifications in rivers have a wider impact, threatening more than the local biodiversity, raises awareness for the fact that all ecosystems are connected. This is aligned with OL principles 1.g., "The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean (…)" and 6.e., "Humans affect the ocean in a variety of ways. (…) Human development and activity lead to pollution (…) and physical modifications (such as changes to beaches, shores and rivers)." (Cava et al., 2005). Promoting environmental activities related to local ecosystems may contribute to promote OL, helping students to feel connected to the ocean. In a project developed to promote OL and the importance of coastal ecosystems, Barracosa et al. (2019) also used a story written by one of the project researchers as a tool for educating on ecosystem services, adopting a local example (estuarine seagrass meadows).

A children's book, used to teach science in the classroom, helps students relate otherwise abstract concepts to the real world (Carr et al., 2001), thus making it a useful tool to promote environmentally friendly behaviors regarding daily habits. As noticed by Hsiao and Shih's (2016) in their research about the use of children's books to teach ideas of environmental protection, they increase children's knowledge of environmental concepts. Moreover, the same study highlighted that reading sessions encouraged a positive change in attitudes, both in school and at home, regarding resources conservation.

Influence of Students' Background Factors

Results demonstrated that students from private schools had better posttest's scores than the ones from public schools. This might be related with the fact that in Portugal, the majority of students from private schools come from families with highly educated parents and with more prevalence of professional jobs, that usually have more educational resources available at home, like books (Pereira, 2010). Besides, they might have more opportunities to attend informal educational settings like zoos and aquaria, experiences that have already been demonstrated to have a positive impact on visitors' knowledge improvement and behaviors, regarding the environment (Falk et al., 2007). The OL Mediterranean survey carried out by Mogias et al. (2019), also revealed that students that have easy access to such educational infrastructures, or that had previously participated in nature-related activities, showed higher knowledge scores. In a study assessing the general public OL in the United States, Steel et al. (2005) found that the difficulties answering ocean-related questions were pervasive, whether coming from coastal or inland respondents. However, the same authors noticed how having the opportunity to visit coastal areas during holidays or leisure time, was a positive factor to acquire ocean content knowledge.

Regarding students' hometown, schools from Lisbon, an urban area, had higher average scores in posttests results, either coming from a private or a public school, compared with Setúbal, a smaller city with a strong fishing heritage. Due to the relationship that Setúbal's inhabitants have with the river and the ocean, allied with their fishing tradition, it was hypothesized that these students had higher scores than those from Lisbon. Once again, these results might be related to the fact that students from Lisbon, a more developed city, have more access to attend informal educational activities or settings. This might be more likely than the geographic location of the schools, since both cities are in coastal and estuarine areas, regardless of Setúbal being under a stronger influence of fisheries tradition.

The effect of the background factors analyzed in the present study enhances the importance of using a children's book to increase awareness of students to environmental issues. Books are accessible tools for teachers, who easily implement an activity as a reading session, since it barely demands specific training for the teacher. Nevertheless, carefully thought must be undertaken by the teacher in the task of choosing the book, taking special attention to the scientific accuracy of the text, since children take as true what they hear in the classroom (Rice, 2002; Pringle and Lamme, 2005).

Assessment surveys, as demonstrated in the present study, are fundamental tools to understand if the growing number of activities implemented in schools to promote the EE and the OL, are contributing to increase student's knowledge and environmental awareness. Moreover, since this research was developed as an outreach project, it was shown that a children's book might be a good tool to promote science communication, as part of the researcher's work, contributing to connect the scientific community with schools and society, besides promoting environmental awareness.

In future editions, the study could be more extended in time to include follow-up activities, and consider more active participation of teachers. They could participate in the reading sessions and answer questionnaires conceived to evaluate their perception of student's change in behaviors regarding environmental issues. Additionally, it would also be relevant to include in the study inland schools, where students have less access to OL activities. Listening and discussing a story focused on a better-known ecosystem (e.g., a river) that connects them and their community to the ocean and the environment could contribute to better understanding of marine ecosystem issues.

Most children enjoy listening to captivating stories, and the overall positive evaluation revealed by the appreciation survey, demonstrates that the book is an effective tool to improve environmental knowledge and at the same time an entertaining activity for the students.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The research has been conducted in accordance with accepted ethics standards as data have been anonymized.

AUTHOR CONTRIBUTIONS

LC and PC conceived the idea. SA, SF, BP, and MC conducted the activities at schools. VS, SF, DB, SA, MF, CB, and MC analyzed the data. LA wrote the manuscript. All authors discussed the project implementation and commented on and approved the final version of the manuscript.

FUNDING

ACKNOWLEDGMENTS

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2021.699122/full#supplementary-material

REFERENCES

Ballantyne, R., Connell, S., and Fien, J. (1998). Students as catalysts of environmental change: a framework for researching intergenerational influence through environmental education. *Environ. Educ. Res.* 4, 285–298. doi: 10.1080/1350462980040304

Barracosa, H., de los Santos, C. B., Martins, M., Freitas, C., and Santos, R. (2019). Ocean literacy to mainstream ecosystem services concept in formal and informal education: the example of coastal ecosystems of Southern Portugal. *Front. Mar. Sci.* 6:626. doi: 10.3389/fmars.2019.00626

Baumann, J. F., and Duffy, A. M. (1997). *Engaged reading for pleasure and learning: A report from the National Reading Research Center*. Athens, GA: National Reading Research Center.

Butzow, C. M., and Butzow, J. W. (1990). Science through children's literature, an integrated approach. *Sci. Act. Classroom Projects Curriculum Ideas* 27, 29–38. doi: 10.1080/00368121.1990.9956738

Carr, K. S., Buchanan, D. L., Wentz, J. B., Weiss, M. L., and Brant, K. J. (2001). Not just for the primary grades: a bibliography of picture books for secondary content teachers. *J. Adolesc. Adult Lit.* 45, 146–153.

Cava, F., Schoedinger, S., Strang, C., and Tuddenham, P. (2005). *Science Content and Standards for Ocean Literacy: A Report on Ocean Literacy*. Available Online at: https://www.coexploration.org/oceanliteracy/documents/OLit2004-05_Final_Report.pdf (accessed January, 2021)

Chaves, L. (2018). *Zé, o Falso Escorpião*. Lisboa: Escola de Mar.

Dowd, F. S. (1991). Storybooks: stimulating science starters. *Sch. Lib. Media Q.* 19, 105–108.

Falk, J. H., Reinhard, E. M., Vernon, C. L., Bronnenkant, K., Deans, N. L., and Heimlich, J. E. (2007). *Why Zoos and Aquariums Matter: Assessing the Impact of a Visit*. Silver Spring, MD: Association of Zoos and Aquariums.

Guest, H., Lotze, H. K., and Wallace, D. (2015). Youth and the sea: ocean literacy in Nova Scotia. Canada. *Mar. Pol.* 58, 98–107. doi: 10.1016/j.marpol.2015.04.007

Hsiao, C. Y., and Shih, P. Y. (2016). Exploring the effectiveness of picture books for teaching young children the concepts of environmental protection. *Int. Res. Geogr. Environ. Educ.* 25, 36–49. doi: 10.1080/10382046.2015.1106203

Kaser, S. (2001). Searching the heavens with children's literature: a design for teaching science. *Lang. Arts* 78, 348–356.

Kelly, R., Evans, K., Alexander, K., Bettiol, S., Corney, S., Cullen-Knox, C., et al. (2021). Connecting to the oceans: supporting ocean literacy and public engagement. *Rev. Fish Biol. Fish.* doi: 10.1007/s11160-020-09625-9 [EpubOnline ahead of print].

Martinez-Conde, S., and Macknik, S. L. (2017). Opinion: finding the plot in science storytelling in hopes of enhancing science communication. *Proc. Natl. Acad. Sci.U. S. A.* 114, 8127–8129. doi: 10.1073/pnas.1711790114

Miles, M. B., and Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.

Mogias, A., Boubonari, T., Realdon, G., Previati, M., Mokos, M., Koulouri, P., et al. (2019). Evaluating Ocean Literacy of Elementary School Students: preliminary Results of a Cross-Cultural Study in the Mediterranean Region. *Front. Mar. Sci.* 6:396. doi: 10.3389/fmars.2019.00396

Monhardt, R., and Monhardt, L. (2000). Children's literature and environmental issues: heart over mind? *Read. Horiz. J. Lit. Lang. Arts* 40, 175–184.

Moser, S. (1994). Using storybooks to teach science themes. *Read. Horiz. J. Lit. Lang. Arts* 35:4.

Muthukrishnan, R. (2019). Using Picture Books to Enhance Ecoliteracy of First-Grade Students. *Int. J. Early Child. Environ. Educ.* 6, 19–41.

National Oceanic and Atmospheric Administration [NOAA]. (2013). *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages Version 2*. Silver Spring: National Oceanic and Atmospheric Administration.

Ocean Literacy Campaign (2013). Ocean Literacy: The Essential Principles of Ocean Sciences K-12. Available at: http://www.coexploration.org/oceanliteracy/documents/OceanLitConcepts_10.11.05.pdf

Pereira, M. C. (2010). Desempenho educativo e igualdade de oportunidades em Portugal e na Europa: o papel da escola e a influência da família. *Boletim Económico/Inverno* 16, 25–48.

Pringle, R. M., and Lamme, L. L. (2005). Using Picture Storybooks to Support Young Children's Science Learning. *Read. Horiz. J. Lit. Lang. Arts* 46, 1–16, doi: 10.1016/j.jecp.2018.04.013

R Core Team. (2019). *R: A Language And Environment For Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.

Rice, D. C. (2002). Using trade books in teaching elementary science: facts and fallacies. *Read. Teach.* 55, 552–565.

Schoedinger, S., Cava, F., and Jewell, B. (2006). The Need for Ocean Literacy in the Classroom: part II. *Sci. Teach.* 73, 48–52.

Stapp, W. B., Bennett, D., Bryan, W., Fulton, J., MacGregor, J., Nowak, P., et al. (1969). The concept of environmental education. *J. Environ. Educ.* 1, 30–31. doi: 10.1080/00139254.1969.10801479

Steel, B. S., Smith, C., Opsommer, L., Curiel, S., and Warner-Steel, R. (2005). Public ocean literacy in the United States. *Ocean Coast. Manag.* 48, 97–114. doi: 10.1016/j.ocecoaman.2005.01.002

US Commission on Ocean Policy [USCOP]. (2004). *An Ocean Blueprint for the 21st Century Final Report (Report No. ISBN#0–9759462–0–X)*. Available Online at: https://govinfo.library.unt.edu/oceancommission/documents/full_color_rpt/000_ocean_full_report.pdf (acessed January, 2021).

United Nations [UN]. (2018). *Revised Roadmap for the UN Decade of Ocean Science for Sustainable Development. IOC*. Paris: Intergovernmental Oceanographic Commission.

UNESCO. (2017). *Education for Sustainable Development Goals. Learning Objectives*. Paris: United Nations Educational and Cultural Organization.

UNESCO-UNEP. (1978). *Final report, intergovernmental conference on environmental education. Tbilisi (ussr), october 14–26, 1977*. Paris: UNESCO-UNEP.

Zambo, D. M. (2007). What Can You Learn from Bombaloo?; Using Picture Books to Help Young Students with Special Needs Regulate Their Emotions. *Teach. Except. Child.* 39, 32–39. doi: 10.1177/004005990703900305