Enhancing marine citizenship as a strategy to promote the reduction of single-use plastics consumption in different cultures

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Single-use plastics (SUP) coming from the land represent a large fraction of marine plastic debris that threatens the ocean biota today and are one of the main causes of microplastic pollution. Consumer behavior is essential to stop the use and improper disposal of SUP, replacing plastic with alternative eco-friendly products. For the evident plastic pollution of beaches and seas, marine citizenship, interpreted as the personal responsibility that individuals take for the oceans, could help to reduce SUP use and change to sustainable alternatives. Here we studied SUP consumption behaviors in Spain (n = 585) and Mexico (n = 337) using a multivariate multiple regression approach. Different policies and social norms in the two countries were reflected in reduced SUP use in Mexico compared to Spain and more recycling in Spain than in Mexico. The main reasons for the use of SUP were the lack of alternatives and forgetting reusable goods in the two countries. Feeling responsible for the ocean predicted the intention to use eco-friendly alternatives, while sea frequentation predicted recycling. Gender, age, and education influenced significantly the willingness to use eco-friendly alternatives. From the results of this study, campaigns promoting awareness through increased ocean literacy and marine citizenship—even in regions far from the sea—could promote reductions in SUP consumption, enhancing the use of sustainable alternatives. Those campaigns could be tailored by country, taking into account local policies and habits, gender, age, and educational levels.

KEYWORDS

consumer behavior, marine citizenship, Mexico, recycling, single-use plastics reduction, Spain

1. Introduction

1.1. How plastics and single-use plastics hamper the sustainable development goals

The United Nations (UN) Sustainable Development Goal SDG#12 is "Ensure sustainable consumption and production patterns", and SDG#14 is "Conserve and sustainably use the oceans, seas, and marine resources for sustainable development" (see the UN Agenda 2030, https://sdgs.un.org/2030agenda, accessed on April 2022). These two objectives are closely connected, because goal 14.1 is the prevention and reduction of marine pollution of all kinds, in particular from land-based activities, and goal 12.5 is to substantially reduce waste generation through prevention, reduction, recycling, and reuse (United Nations, 2015). In this scenario, plastic is perhaps the biggest problem, with trillions of plastic pieces floating at sea (Eriksen et al., 2014). Regarding its dimension, ubiquity, and impacts on biota, marine plastic pollution is considered a planetary boundary threat (Villarrubia-Gómez et al., 2018). Indeed, the majority of plastic debris in the ocean comes from the land (Carroll et al., 2014; Jambeck et al., 2015; Chassignet et al., 2021). Plastic pollution is dramatically harmful to marine life, causing suffocation, entanglement, and high mortality in animals from fish to seabirds to cetaceans (Gall and Thompson, 2015; Li et al., 2016). Moreover, plastics represent a new habitat for invasive species that can be transported by fouling on them with the currents, even to remote islands (Rech et al., 2018). It is also the main cause of the emergent microplastic pollution in the ocean that comes largely from the breakage of plastics improperly disposed of (Wayman and Niemann, 2021).

Single-use plastics (SUP) coming from the land represent a large fraction of marine plastic debris. The production of SUP has doubled since 2000, and only a small amount of the total SUP produced is currently recycled, while the majority is incinerated or landfilled, then entering the sea through surface runoff (Chen et al., 2021). On a global scale, there are regional differences in the mismanaged plastic waste produced on the coast and ending in ocean water. Chassignet et al. (2021) found that Asian countries, the eastern Mediterranean basin, the Gulf of Guinea, the Atlantic coast of Mexico, the Caribbean Sea, and Central America are plastics emission hotspots, with the southeast of Africa following close with as many as 10^4–10^5 plastic waste particles beached by $1 \times 1°$ surface in 2010–2019. In contrast, plastics that landed on Atlantic European, North American, Pacific South American, and Australian coasts are in general much fewer—with some exceptions like spots in the Baltic Sea (Chassignet et al., 2021). Many SUP are not necessary or can be easily replaced by reusable goods, like plastic straws, portable cutlery, and others. Some SUP such as plastic bags, which can be substituted by reusable bags, are an important part

of current marine pollution and the main focus of many studies about SUP consumption and the efficiency of policies to reduce it in Africa (Adam et al., 2020; Wahinya and Mironga, 2020), America (De Groot et al., 2013; Jakovcevic et al., 2014), Asia (Asih et al., 2020; Vassanadumrongdee et al., 2020), and Europe (Martinho et al., 2017; Loy and Reese, 2019).

1.2. Single-use plastics and the R imperatives

Around the world, countries have approached the environmental challenge caused by SUP in different ways. Some have opted to use a top-down approach and, following the advice of international institutions, have adopted institutional policies from the Government (at a national or state scale) to ban different types of SUP, like plastic bags (Muposhi et al., 2022). Other countries have introduced taxes or levies and many have not started to tackle the problem yet (reviews by Adeyanju et al., 2021; Borg et al., 2022). There are pieces of evidence of regulations based on applying taxes or levies that significantly reduce SUP consumption and promote attitude, perception, and behavior change toward eco-friendly products; however, the effectiveness of those regulations is variable (Adeyanju et al., 2021). Bans are generally well accepted, but not in all countries (Borg et al., 2022). For example, Kenyan consumers complain about current plastic bans that seem to be producing a porous black market (Wahinya and Mironga, 2020).

In the majority of countries, where bans are not applied, SUP are indeed available. Consumer behavior is essential to stop SUP use and improper disposal. Because the 10 most commonly found SUP items on European beaches are more than 50% of the total marine litter in European waters, the EU focuses first on limiting SUP use (Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment). Voluntary actions to reduce SUP usage are necessary to interrupt and prevent the growing SUP pollution (Chen et al., 2021). Beyond the triad reduce–reuse–recycle, the extended 10-R strategies (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover), which are crucial in the circular economy (Kirchherr et al., 2017), may define the framework of individual and societal behaviors desired to solve this problem. The individual refusal of consuming SUP would indeed cut drastically the current accumulation of SUP waste if the behavior were adopted at a large scale, as estimated by Lau et al. (2020) for the scenarios "reduce" and "substitute". Reducing the purchase of SUP, reusing or using them for another purpose, and sorting and disposing of them in the proper trash bin to enable recycling will no doubt help to reduce SUP waste. However, adopting these

behaviors is not always easy. Consumer culture and habits influence individual SUP consumption and may hamper the reduction of SUP consumption (Wiefek et al., 2021). The lack of plastic-free alternatives is a major impediment for many consumers (Heidbreder et al., 2020). SUP materials could be replaced by eco-friendly alternatives like non-plastic or biodegradable plastics, which are generally preferred by consumers over plastic packages (Dilkes-Hoffman et al., 2019a; Gill et al., 2020). Providing plastic-free alternatives is also the preferred intervention for reducing plastic bags in South Africa (O'Brien and Thondhlana, 2019), but they may be difficult to identify. The lack of knowledge about different packaging types is a barrier to the reduction of SUP usage in many countries (Jacobsen et al., 2022) as well as the unawareness of the impacts of plastic (Xanthos and Walker, 2017; Vimal et al., 2020). Knowledge, awareness, and consumer attitudes are indeed important to determine SUP reduction, but other factors are involved too. We revise next the psychosocial theories behind SUP consumption behavior.

1.3. Theoretical frameworks to explain single-use plastics consumption behaviors

Like many other issues concerning the environment, in SUP consumption, the theoretical frameworks most frequently employed to explain the different consumer behaviors are the theory of planned behavior (Fishbein and Ajzen, 1975) and the theory of reasoned action (Ajzen and Fishbein, 1980). In these models, evaluative beliefs (about the consequences of the actions) and normative beliefs (about what society expects from us, or social norms) together with the motivation to comply with them will determine respectively attitudes toward a behavior and subjective norms. The combination of those— their relative importance and direction, being favorable or unfavorable toward the pro-environmental action—will influence behavioral intentions, which will be finally transformed into actual behavior (Ajzen and Fishbein, 1980). Sun et al. (2017) found good support for this theory in China, where attitude, perceived social norms, and subjective norms, together with convenience, explain the use of plastic bags. The importance of social norms for SUP reduction has been also highlighted in Canada, where normative (personal and/or injunctive) messages reduced the use of plastic bags more than when only environmental messages were employed (De Groot et al., 2013).

Subsequently, Hines et al. (1987) proposed their model of responsible environmental behavior based on Ajzen and Fishbein (1980). The model starts from the locus of control (perceived capacity to carry out the action), the individual sense of responsibility, and the attitude as the personality factors that, together with knowledge and the actual skills to act, will

determine the behavioral intention. Finally, if situational factors are favorable, the individual will act pro-environmentally (Hines et al., 1987). Examples like a study in Bali would support this model: social norms did not significantly explain SUP bag consumption; knowledge, environmental concern, and perceived control predicted the use of reusable bags instead (Asih et al., 2020). In a recent review, Jacobsen et al. (2022) reformulated the theoretical SUP framework as the triad of "ability, motivation, and opportunity". They identified environmental concerns and social norms as the main motivation factors to reduce SUP consumption.

Building on previous theories that were based principally on reasoning, Kollmuss and Agyeman (2002) introduced emotions in their pro-environmental behavior theory, explaining it as the result of complex interactions between internal (knowledge, values and attitudes, feelings, and emotional involvement) and external (infrastructure, culture and politics, economic situation) factors. Feelings of guilt about nature deterioration (called eco-guilt by some authors) explain, significantly, pro-environmental perceptions and behavior in different studies (Mallett, 2012; Rees et al., 2015; Wang and Lin, 2018). In an experimental study in Europe and North America, Zwicker et al. (2020) increased the willingness to pay for plastic reduction by manipulating guilt. Here we will introduce emotions to explain the environmental behavior of SUP as well. Since plastic pollution links inextricably SUP consumption with an enormous deterioration of the oceans, we will add marine citizenship feelings to our models.

1.4. Marine citizenship as an internal and situational factor to promote single-use plastics reduction

Marine citizenship describes a state where individuals have rights and take personal responsibilities for the oceans (McKinley and Fletcher, 2012). Individuals feel responsible for the ocean and make lifestyle choices to minimize their environmental impact (Fletcher and Potts, 2007). Marine environmental education and personal attachment to the marine environment (including the proximity to the coast, memories of holidays and recreation, historical connections with the marine environment, and others) join the feeling of personal responsibility as key themes for the development of marine citizenship (McKinley and Fletcher, 2010). The plastic pollution of beaches and seas is evident on many coasts worldwide; thus, it seems logical that sea frequentation, the objective and less emotional part of marine citizenship, makes visitors aware of the degradation caused by plastic pollution. An example is German anglers who are concerned about marine litter and consequently prevent fishing gear losses in the Baltic Sea (Lewin et al., 2020). However, on a Greek island where the sea is constantly accessible, Latinopoulos et al. (2018) did not find a significant effect of informative campaigns about the

negative impact of plastics on the willingness of consumers to reduce plastic bags. It seems that the simple presence of the sea around is not sufficient to link SUP use and environmental impact and act accordingly.

Environmental awareness is needed to realize that beaches are littered and to act pro-environmentally. Beach visitors adopt sustainable behaviors about litter and litter disposal when they are environmentally aware, as confirmed in Spain, where the level of beach littering is negatively correlated with the awareness of beachgoers about marine litter (Rayon-Viña et al., 2018). If marine citizens feel responsible for the ocean, we could expect them to behave consciously about SUP because plastic pollution is so evident on beaches and seawater worldwide. Environmental concern is an important driver of SUP reduction behavior (Walker et al., 2021; Jacobsen et al., 2022). The concern about the ocean, feeling personally responsible for the sea—which is key in marine citizenship (Fletcher and Potts, 2007; McKinley and Fletcher, 2012), is perhaps stronger than the mere sea frequentation as a motivation to behave consciously about SUP.

As explained above, pro-environmental behavior is difficult to predict because it is the product of complex interactions between many factors (Kollmuss and Agyeman, 2002). Just feeling as a marine citizen is probably insufficient to behave responsibly about SUP and plastic litter. Social norms are very important to motivate individuals about SUP reduction (Jia et al., 2019; Jacobsen et al., 2022). Social norms represent what is right, normative, or appropriate in society and are as important as hedonic and gain goals to motivate plastic mitigation actions (Steg et al., 2014; Jia et al., 2019). If they are not favorable to plastic reduction, social norms may be major obstacles to the rejection of SUP (Heidbreder et al., 2019). There are differences among countries in the social norms about SUP. A survey involving 20,513 adults from 28 countries revealed that, for example, in Mexico, the level of agreement with banning SUP is as high as 88%, and 84% of citizens think that an international treaty to combat plastic pollution is necessary, while these values are 78% and 68% in Spain and as low as 37% and 27% in Japan (IPSOS/Plastic Free July, 2022). Therefore, we expect differences between countries depending on their social norms.

1.5. Sociodemographic determinants of plastic use behavior

Sociodemographic factors like gender, age, education, and income have been related to SUP consumption and littering behavior in many studies. The results, however, may vary greatly among countries and types of sustainable behavior. Older people, and those with a higher level of education and income, litter less and manage waste better than younger people or those with a lower level of education, according to different studies in the USA (Bator et al., 2011), Australia (Slavin et al., 2012), and Spain (Escario et al., 2020). However, younger people consume

less SUP than older people in South Africa (O'Brien and Thondhlana, 2019); and high-income people use bottled water more frequently than low-income people in Ghana, where bottled water is perceived as more hygienic and safe (Abrokwah et al., 2021).

Regarding gender, women are more concerned about the impact of SUP in Vietnam (Nguyen et al., 2022) and Australia (Dilkes-Hoffman et al., 2019b), take more actions to prevent beach litter in Tasmania (Slavin et al., 2012), do more litter sorting in Ghana (Owusu et al., 2013), and reduce and reuse (but not recycle) more frequently than men in Spain (Escario et al., 2020). In contrast, men act against beach litter more frequently than women in Spain (Rayon-Viña et al., 2018). Interestingly, in a study in Canada, the use of SUP packaging does not seem to vary significantly across ages, genders, and educational levels (Walker et al., 2021). From these results, it seems that generalizations are not possible and that sociodemographic factors may influence consumer behavior differently, depending on the country and the circumstances.

Finally, it seems that marine citizenship itself may be also influenced by socio-economic factors. Although women are frequently invisible in many maritime sectors, like fisheries (e.g., Koralagama et al., 2017), the value of the ocean and the activities linked to it seem to be greater for women than for men, as suggested from surveys in Canada (Guest et al., 2015) and Spain (García-Gallego et al., 2021).

1.6. Objectives, expectations, and departure hypotheses

Since there is no consensus about the most effective ways to curb the use of SUP on a global scale, many authors highlight the importance to find new ways to encourage citizens to responsibly reduce SUP consumption (Heidbreder et al., 2019; Adeyanju et al., 2021; Borg et al., 2022), and not only plastic bags, which have been the main focus of studies so far (Adeyanju et al., 2021). Including measures of observed behavior is also recommended (Borg et al., 2022), because in the use of SUP, there is a big gap between intention and behavior (Ertz et al., 2017). Since awareness and attitudes have been more studied, Borg et al. (2022) suggested that further studies focus on what to do to motivate consumers to reduce and reuse SUP.

The main objective of the present study is to introduce marine citizenship as a possible way of motivating consumers to responsible SUP consumption behavior. We will explore how two aspects of marine citizenship, sea frequentation and the feeling of responsibility for the ocean, can influence SUP-related behavior in countries with different social norms about SUP consumption, Mexico and Spain, with the former being more favorable to SUP bans than the latter. We will test a model (Figure 1) where marine citizenship, independently of social norms, increases the intention to reduce the
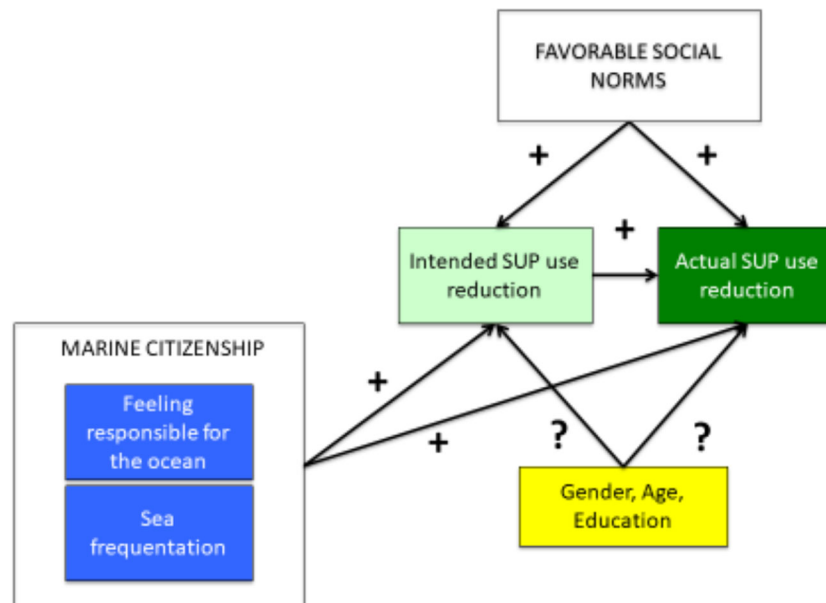
FIGURE 1
Graphical summary of the model tested in this study. Arrows represent relationships between variables. The sign of the expected relationship is indicated.

consumption of SUP bags and bottles, with intention determining further actual reduced SUP consumption. The sociodemographic factors of gender, age, and education would mediate these relationships.

To check the applicability of marine citizenship as an enhancer of other environmental behaviors, we will tackle its effects on litter sorting as well. This practice is widely implemented and generalized in Spain, where approximately 80% of citizens usually separate glass, paper, and plastic (Escario et al., 2020; Gibovic and Bikfalvi, 2021), while in Mexico, the management of solid urban waste is a priority but is still a challenge in many areas (Munoz-Melendez et al., 2021). Researchers propose therein improvements to the best implementation of the federal legal framework for pollution regarding plastics (Lara et al., 2020). Thus, the social norm is expectedly more favorable to litter sorting in Spain than in Mexico.

From the model summarized in Figure 1 and the references above, our hypotheses were as follows:

  I. Marine citizenship, i.e., feeling responsible for the ocean and (perhaps) sea frequentation, will predict SUP reduction and the use of eco-friendly alternatives in Mexico and Spain.
  II. Sociodemographic factors like gender, age, and education will mediate between marine citizenship

and the intention to reduce SUP. The direction and intensity of the mediation may be different in Mexico and Spain.

  III. From policies and social norms in Mexico and Spain, the intended reduction of SUP consumption will be higher in Mexican than in Spanish samples of similar education and age.
  IV. Social norms, marine citizenship, and sociodemographic factors will determine litter sorting. For different policies and social norms about recycling, this pro-environmental behavior is expected to be higher in Spain than in Mexico.

2. Material and methods

2.1. Ethics statement

This study was approved by the competent Committee of Research Ethics of Asturias Principality with reference CEImPA:2021.116. The participants were informed about the objective of the study and about their right to withdraw from the study at any moment, and they signed an informed consent document. This study followed the principles of the Declaration of Helsinki and aligns with the European guidelines for ethics in research (European Commission, 2013).

2.2. Questionnaire

2.2.1. Development of the questionnaire

The tool applied in this study was a questionnaire aimed at gathering information about the following issues: sociodemographic data, marine citizenship, actual use of SUP and reasons for it, and intention to adopt a sustainable use of SUP. Regarding sociodemographic data, we have chosen factors that, from scientific literature, can influence the use of plastics.

Marine citizenship was measured independently from two proxies. One was the actual use of the sea and the other was the feeling of responsibility for the sea, which are key components of this state (McKinley and Fletcher, 2012). Beach frequentation was taken as a proxy for the use of the sea, and the feeling of guilt about harming the sea was taken as a proxy for feeling responsible for the sea as a variant of eco-guilt (Mallett, 2012) specifically referred to the sea.

The actual use of SUP was focused on two common goods of frequent use in the majority of countries: plastic bags and plastic bottles. The following R imperatives were considered: reducing (SUP use), reusing (SUP), repurposing (using SUP for another purpose), recycling (for this proper SUP disposal and litter sorting is required from the consumer), and refusing (SUP use).

The intention to adopt sustainable behaviors about SUP considered the following R imperatives: reducing, recycling (litter sorting), and replacing (using eco-friendly products).

The questionnaire applied (Table 1) was designed based on the questionnaires validated and used by Lee et al. (2014); Rayon-Viña et al. (2018); Deng et al. (2020), and Yoon et al. (2021). The sociodemographic questions and those about the frequency of and reasons for SUP use were adapted from Deng et al. (2020), who applied their questionnaire in Shanghai from 437 respondents. The questions about the intention to behave sustainably regarding plastics consumption and disposal were adapted from the Lee et al. (2014) questionnaire that was applied and validated in South Korea (416 respondents). The question about beach frequentation was taken from Rayon-Viña et al. (2018), who applied it in a survey about marine litter perception in Spain (201 respondents). Yoon et al. (2021) applied the question about the feeling of being able to harm the marine environment in Korea, China, Japan, and the Americas.

2.2.2. Questionnaire structure

The structure of the present questionnaire (Table 1) has three blocks: a) sociodemographic data and sea frequentation; b) actual behavior about the use of SUP including frequency of SUP acquisition, reasons for its use, and disposal of the SUP acquired; and c) feeling of responsibility about the ocean and intention of sustainable behavior about plastics, including reduction of plastics use and litter sorting. The questions were translated into Spanish, which is the language of the countries of the study. The details of questionnaire scoring are in Supplementary Table 1.

2.3. Single-use plastic status in the regions studied

The study was conducted in the Mexican State of Hidalgo and Spain. In these countries, there was no SUP ban at the moment of the study. In 2021, in Spain, a plastic bag levy was applied in stores and supermarkets in the application of the Royal Decree that regulates the consumption of plastic bags and creates a register of producers (Real Decreto 293/2018, 18 May, available at https://www.boe.es/eli/es/rd/2018/05/18/293). Plastic bottles (of water, soda, juice, and other beverages) were commonly available in stores and vending machines. In Mexico, federal laws limiting plastic bags were not in force in 2021, but taxes or bans were applied in various States including Hidalgo. Mexico DC was one of the first largest cities in the world to ban single-use plastic bags, as early as 1 January 2020. Plastic bottles containing water and other beverages were commercialized normally in the two countries in 2021.

2.4. Sampling methodology and samples

The questionnaire was self-administered online. The link was given to the participants by email with a brief message stating that the survey was aimed at knowing about plastics consumption, that it was for research use only, anonymous and voluntary, and thanking the respondent for their participation. As explained above, before accessing the questionnaire, the participants found an information page about the project, authors, and policy for anonymous data treatment and had to sign the informed consent.

Two types of respondents were targeted: university students and the general population. University students were chosen because they represent homogeneous samples of a similar educational level and age; therefore, intercultural differences can be investigated without complex interferences with the mentioned variables. A general population sample allows for the exploration of the effects of sociodemographic factors like age and educational level, which are homogeneous in student samples, thus inferring if the results obtained from students could be similar in other population groups of the same country.

Researchers directly contacted university students in Spain (the University of Oviedo and the National University of Distance Education) and Mexico (Autonomous University of Hidalgo State) on their academic emails. Spanish students were asked to contact people outside their university among their acquaintances and pass them a link to the online questionnaire. This snowball sampling, a chain-referral method, is very useful to recruit samples of hard-to-reach communities (Valerio et al., 2016). In the present case, it was chosen because, expectedly, the groups of people contacted by students would belong to a similar (or not very different) culture within each country.

TABLE 1 Questionnaire employed in this study.

Block A: Sociodemographic questions

Items	Options
A1 Gender	Female/Male/Non-binary
A2 Age	18–30/31–40/41–50/51–60/>60
A3 Educational level	Junior high school or lower/Senior high school/Vocational college/Undergraduate/Graduate or above
A4 Personal income per month ($ or equivalent)	<500/500–1,000/1,000–2,000/2,000–3,000/3,000–5,000/>5,000
A5 What is/was your field of education	Open answer
A6 How often do you go to the beach/sea?	Every day/Weekly/Monthly/Only in my vacations/Rarely/I don't like the beach
Block B: Single-use plastics consumption and disposal. Adapted from Deng et al. (2020)	
B1 How often do you acquire new plastic bag(s) while shopping in supermarkets?	Every time/Usually/Sometimes/Seldom/Never
B2 How often do you buy single-use water plastic bottles?	Every time I buy drinking water/Usually/Sometimes/Seldom/Never
B3 Do you sort your garbage before disposing?	Every time/Usually/Sometimes/Seldom/Never
B4 How do you deal with the used plastic bags and bottles?	Dispose as general trash/Dispose in the recycling bin/Reuse/Use for other purposes/I never use this type of goods
Please choose a reason for your acquisition of B5 plastic bags/B6 bottles	Convenience/Reusability/Affordability/Lightweight/Forgetting reusable goods/Lack of alternatives/Other
Block C: Feeling of guilt (= responsibility) and intended R behavior. Adapted from Yoon et al. (2021)	
Please rate the following statements	
C1 I feel I could harm the marine ecosystem	Between 1 = I totally disagree and 7 = I totally agree
C2 I will reduce plastics use	Between 1 = extremely unlikely and 7 = extremely likely
C3 I will sort waste for recycling	Between 1 = extremely unlikely and 7 = extremely likely
C4 I will buy eco-friendly products whenever possible	Between 1 = extremely unlikely and 7 = extremely likely

The participants who completed the questionnaire over 90% of the questions ($N = 932$) are described in Table 2. A total of 248 students in Spain, 337 students in Mexico, and 347 non-students in Spain completed more than 90% of the items of the questionnaire. Gender ratios as % of female were 0.74, 0.66, and 0.56, respectively. The numbers of respondents identified as non-binary were respectively 2, 3, and 2. These seven individuals were not included in analyses by gender owing to their small number. The academic profile, income levels, age, and gender ratios were similar and homogeneous in Mexican and Spanish university students, with a majority of education students and the great majority of respondents under 30 (Table 2). Regarding Spanish non-students, the majority were graduates. The education fields were more or less balanced, between 1% in agriculture and 18% in the field of construction and engineering. The sample was more or less balanced in gender (56% female), and among age groups, the majority (32%) were under 30 (Table 2).

2.5. Data analysis and statistics

Differences between samples for the distribution of qualitative variables, i.e., the reasons for the acquisition of SUP or the ways of disposing of SUP bags and bottles, were tested using the contingency chi-square approach and *post-hoc* tests. The effect size was estimated from Cramer's V, interpreted as weak in the range 0.07–0.21, medium in 0.21–0.35, and large when >0.35 for two degrees of freedom (d.f.) (Sun et al., 2010).

The quantitative variables considered for analysis were sea frequentation (1–6 scale), feeling responsible for the sea (1–7 scale), intention to reduce SUP (1–7), reduced use of SUP bags and bottles (1–5, the highest value corresponding to no use of those goods), intention to sort litter (1–7), frequency of litter sorting (1–5), age (1–5), educational level (1–4), and personal income (1–6). Dummy 0–1 was employed for gender (1 for female and 0 for male). For visual representations, the values were transformed to a 1–7 scale.

Normality in datasets was checked using the Shapiro–Wilk tests and homoscedasticity (homogeneity of variances) using the Breusch–Pagan test. When these requisites were confirmed, ANOVA and *post-hoc* Tukey's pairwise tests were employed to determine differences in behavioral variables (reduced consumption of SUP bags or bottles, litter sorting) between samples. If the requisites were not met, the Kruskal–Wallis (Hc tie-corrected test) and *post-hoc* Mann–Whitney tests were employed instead.

Multivariate multiple regression models were run to test the predictive value of independent variables (marine citizenship and sociodemographic factors) on pro-environmental behavior

TABLE 2 Sociodemographic characteristics of the samples analyzed: students from Mexico and Spain and non-students from Spain.

N		Spain students 248	Mexico students 337	Spain non-students 347
Gender	Female	0.742	0.656	0.565
	Male	0.25	0.335	0.429
	Non-binary	0.008	0.009	0.006
Age	Under 30	0.84	0.97	0.32
	30–40	0.09	0.027	0.16
	40–50	0.04	0	0.19
	50–60	0.03	0.003	0.23
	>60	0	0	0.10
Income	0–500	0.84	0.69	0.21
	500–1,000	0.06	0.15	0.17
	1,000–2,000	0.07	0.07	0.41
	2,000–3,000	0.026	0.04	0.13
	>3,000	0.004	0.05	0.08
Education field	Agriculture	0.02	0.04	0.01
	Education	0.60	0.56	0.16
	Engineering, manufacturing and Construction	0.02	0.01	0.17
	General programs	0.02	0.11	0.11
	Health and welfare	0.22	0.04	0.12
	Humanities and arts	0.02	0.02	0.07
	Science	0.05	0.02	0.09
	Services	0.01	0.01	0.10
	Social sciences, business, and law	0.04	0.19	0.17
Educational level	Junior high school	0	0	0.04
	Senior high school	0	0	0.11
	Vocational college	0	0	0.25
	Undergraduate	1	1	0.11
	Graduate or above	0	0	0.49

Education fields follow the International Standard Classification of Education (ISCED, 2011). Results are presented as the proportion of participants in each category, per sample.

and behavior intention (dependent variables). Sea frequentation and feeling of responsibility for the ocean were treated as two separate independent variables. Other independent variables were the gender dummy, age, educational level, and income. This analysis was carried out separately for students and non-students. For students, the only sociodemographic variable considered was the gender dummy, because the samples were homogeneous for the rest of the sociodemographic variables considered. For non-students, all the sociodemographic variables were considered.

To test the mediation role of a variable, we followed MacKinnon et al. (2002) and Wuensch (2012). For this, we calculated β = unstandardized regression coefficient for predicting the mediator (a sociodemographic variable) from the independent variable (any component of marine citizenship) and α = partial unstandardized regression coefficient for predicting the pro-environmental behavior or behavior intention from marine citizenship, holding constant the sociodemographic variable. These variables were divided by the respective standard errors to calculate Z_β and Z_α scores. For a 0.05 non-directional test, the critical value of the statistics $Z_\alpha * Z_\beta$ is 2.18; higher values can be considered significant.

Pairwise correlations between variables were calculated using Pearson's r. Multicollinearity was tested using the variable inflation factor (VIF):

$$\mathrm{VIF}_i = 1/\left(1 - \mathrm{R}_i^2\right)$$

A standard significance threshold of $p < 0.05$ was adopted, applying Bonferroni's correction for multiple comparisons, whenever relevant. Statistics were carried out with free software PAST version 2.17c.

3. Results

The raw results of this study are openly available at the public EU online repository EUDAT with the following DOI: 10.23728/b2share.0b02d78b523544a3a76c621da6c723d2 and

permanent PID http://hdl.handle.net/11304/862b380e-da27-495a-85a8-9b2938bcc49c. They include the questionnaire items and the individual answers of the 932 respondents who completed the questionnaire.

3.1. Single-use plastics consumption behaviors

Survey results revealed differences in the two components of marine citizenship considered, and also in SUP consumption, between the samples analyzed (Figure 2, Supplementary Table 2 for statistics summary). Sea frequentation (Hc = 225, $p \ll 0.001$ in the Kruskal–Wallis test for between-sample differences) was much lower in Mexican students (mean 2.2 in untransformed average, which is between rarely and only in vacations;

Figure 2A) than in the two Spanish samples (untransformed means of 3.2 and 3.1, respectively, between only in vacations in and monthly), which did not differ significantly from each other (Supplementary Table 2, *post-hoc* test not significant). Not frequenting the sea did not mean a lack of responsibility for it in this study. On the contrary, the significant differences between the three samples ($F_{(2,929)}$ = 5.44, p = 0.005; Supplementary Table 2) were due to a lower feeling of responsibility of Spanish non-students (Figure 2B) in comparison with the two student samples, despite them visiting the sea significantly more frequently than Mexican students. Mexican and Spanish students did not differ from each other.

The intention to reduce SUP was the highest in Mexican students (Figure 2A), then in Spanish students (Figure 2A), and finally in Spanish non-students (Figure 2B). The Kruskal–Wallis test was significant (Hc = 6.87, p = 0.02; Supplementary Table 2),
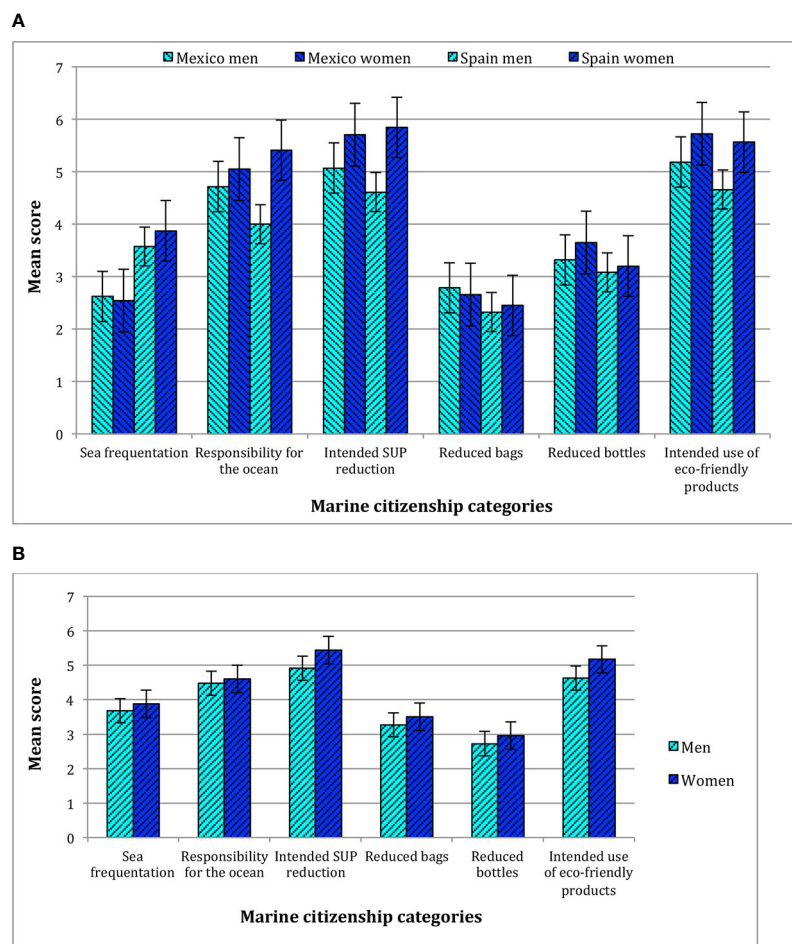

FIGURE 2
Marine citizenship measured from sea frequentation and feeling of responsibility for the ocean and single-use plastics consumption behavior (as reduced use of these items) in the Mexican and Spanish samples of students **(A)** and the Spanish sample of non-students **(B)** analyzed. Results are presented as mean scores, with standard errors as capped bars.

and the *post-hoc* Mann–Whitney tests revealed significant differences only between the highest Mexican students and the lowest Spanish non-students samples (Supplementary Table 2).

Reduced SUP bag consumption was clearly lower than the intention to reduce SUP in all three samples. It was significantly different between samples too (Hc = 176, *p*<< 0.001), and the three samples differed significantly from each other in *post-hoc* tests (Supplementary Table 2). The highest reduction of SUP bags corresponded to Spanish non-students (Figure 2B). In the student samples (Figure 2A), consumption of SUP bags was reduced significantly more in Mexican than in Spanish students.

The consumption of SUP bottles was also significantly different among samples (Hc = 44.2, *p*< 0.001, all *post-hoc* tests being significant; Supplementary Table 2). Mexican students reduced SUP bottle consumption the most (Figure 2A), followed by Spanish students (Figure 2A), and then Spanish non-students (Figure 2B).

The last pro-environmental behavior considered in this part, the intention to use eco-friendly products, followed a similar trend to that found for the intention to reduce SUP and the actual reduction of SUP bottles. Mexican students intended to buy more eco-friendly products than Spanish students (Figure 2A), and these more than Spanish non-students (Figure 2B). The differences were again statistically significant (Hc = 21.77, *p*< 0.001), and, like in the case of SUP bottle consumption, all the *post-hoc* tests were statistically significant (Supplementary Table 2).

Mean scores were higher for women than for men for the majority of variables measured, in all the samples. This will be analyzed in detail later.

The respondents declared varied reasons for the use of SUP (Figure 3) and not the same for plastic bags and bottles. The majority of respondents in the three samples declared to use SUP bags when they forget to bring alternative reusable bags (Figure 3); the maximum was in Spanish students, with more than 73% alleging this reason (Figure 3A). The second frequent reason was reusability for Mexican students (Figure 3A) and convenience for both Spanish students (Figure 3A) and non-students (Figure 3B). Less than 20% of participants chose any other reason, including typical plastic advantages such as affordability, lightweight, or hygiene. The difference between the three samples was highly significant (χ^2 = 51.4, 14 d.f., *p*<< 0.001, Cramer's V = 0.13, indicating a large effect size for 14 d.f.), as it was the difference between Mexican and Spanish students (χ^2 = 30.6, 7 d.f., *p*<< 0.001, Cramer's V = 0.18, a medium-to-large effect size for 7 d.f.) and between Mexican students and Spanish non-students (χ^2 = 34.6, 7 d.f., *p*<< 0.001, Cramer's V = 0.18). The two Spanish samples were not significantly different, indicating similar use of plastic bags (χ^2 = 10.4, 7 d.f., *p* = 0.17 > 0.05 n.s., moderate Cramer's V = 0.10).

The use of SUP bottles was explained principally by forgetting reusable bottles in the case of student samples,

principally in Mexican students (55% of participants), while the reason most frequently alleged by Spanish non-students was the lack of alternatives (Figure 3B). As in the case of SUP bags, in Spain, the second frequent reason was convenience (for both students and non-students), while for Mexican students, it was reusability again, like for the consumption of plastic bags. The third frequent reason was a lack of alternatives for both Mexican and Spanish students and forgetting reusable goods for Spanish non-students. The rest of the reasons were chosen by less than 20% of the participants. The difference among the three samples was statistically significant (χ^2 = 73.1, 14 d.f., *p*<< 0.001, large Cramer's V = 0.16), as were the differences between all the pairs of samples in *post-hoc* tests (data not shown).

Regarding the after-use fate of the consumed SUP (Figures 4A, B), the majority of respondents declared to give SUP bags and bottles a second use, for another or the same purpose, in the three samples. The third choice was to dispose of SUP objects in recycling bins (26%, 18%, and 7% of Spanish non-students, Spanish students, and Mexican students, respectively), followed by disposal as general trash (around or less than 5%) and a minority of participants who never use SUP (2% of Spanish samples and 1% of Mexican students).

The three samples differed significantly in their SUP disposal behavior (χ^2 = 55.2, 8 d.f., *p*<< 0.001, Cramer's V = 0.18, meaning a medium-to-large effect size for 8 d.f.). However, SUP disposal choices were not significantly different between Spanish students (Figure 4A) and non-students (Figure 4B) (χ^2 = 9.4, 4 d.f., *p* > 0.05 n.s., weak Cramer's V = 0.12 for 4 d.f.), who tended to reuse these SUP less frequently than Mexican students do (near 90% of Mexican students declared to reuse SUP, while this proportion was about 76% and 67% in Spanish students and non-students, respectively). Indeed, the difference between Mexican and Spanish students was significant (χ^2 = 19.5, 4 d.f., *p*<< 0.001, V = 0.18, a medium-to-large effect size), as well as the difference with Spanish non-students (χ^2 = 53.99, 4 d.f., *p*<< 0.001, V = 0.28 large effect size).

3.2. Recycling behavior

Litter sorting—which is required for recycling—is indeed related to plastic mitigation, and from the current recycling policies, we expected it to be higher in Spain than in Mexico. The expectation was confirmed in our samples, where actual litter sorting behavior was more frequent in the two Spanish samples than in Mexican students (Figure 5, dark green). The difference between the three samples was highly significant (ANOVA with $F_{(2,929)}$ = 45.83, *p*< 0.001). The two Spanish samples did not differ from each other (Tukey's test = 0.0002, *p* ≈ 1), and the two Spanish samples differed significantly from Mexican students (Tukey's test = 11.37 with *p*< 0.001 in the two comparisons).
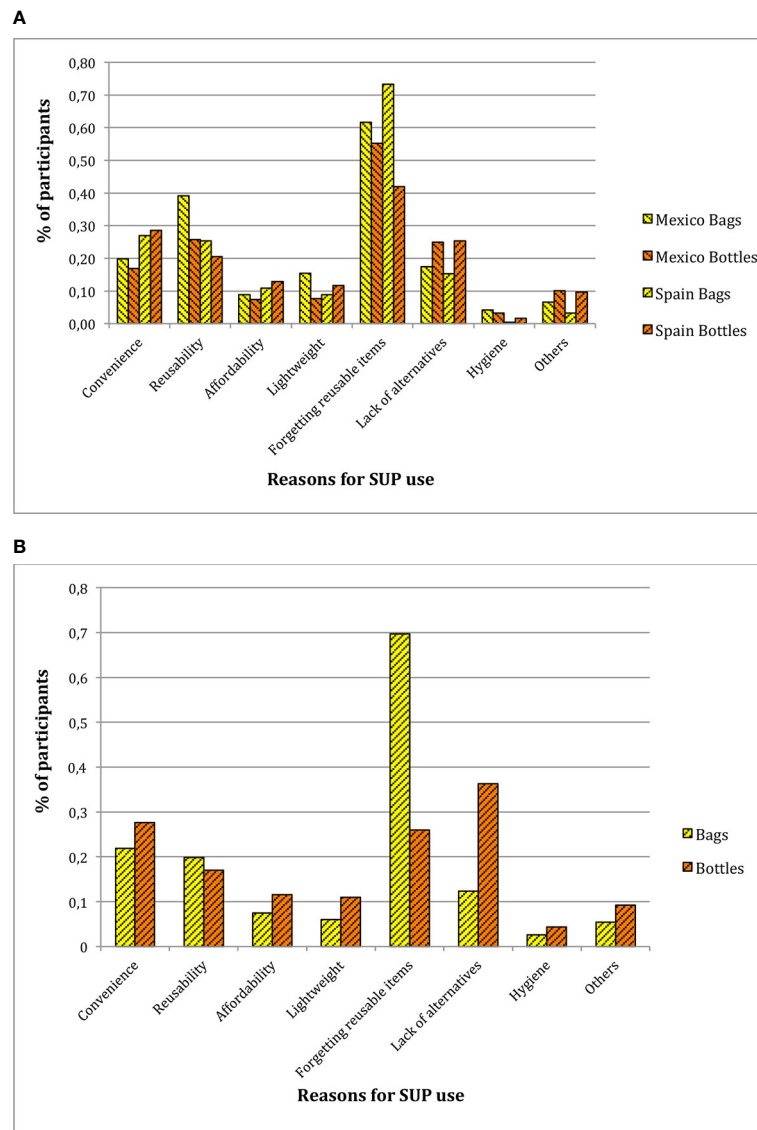
FIGURE 3

Reasons for the use of single-use plastics in Mexico and Spain student samples **(A)** and the sample of Spanish non-students **(B)**, being plastic advantages, lack of alternatives, forgetting reusable objects, or others. Results are presented as the proportion of participants who use single-use plastics (SUP) for each reason. Note that the sum is >100% in each sample because marking more than one option is possible in these questions.

The intention to sort waste (Figure 5, light green), although generally higher than the actual behavior (especially in Mexican students), followed a similar trend. It was also significantly different among samples (homoscedasticity not accomplished; Hc = 14.36, p = 0.0008), being not significantly different between Spanish samples (Mann–Whitney with p = 0.06 > 0.05 n.s.) and higher in the two Spanish samples than in Mexican students (Mann–Whitney with p = 0.002 and 0.04 for *post-hoc* comparisons of Mexican students versus Spanish students and non-students, respectively).

3.3. Effect of marine citizenship and sociodemographic variables on pro-environmental behaviors

The two components of marine citizenship here analyzed were clearly different in their relation to pro-environmental behaviors. In simple pairwise correlations (Supplementary Table 3), the feeling of responsibility for the sea was correlated significantly with the intended pro-environmental behavior in the three samples. In contrast, sea frequentation was correlated with the actual recycling behavior in the two Spanish samples
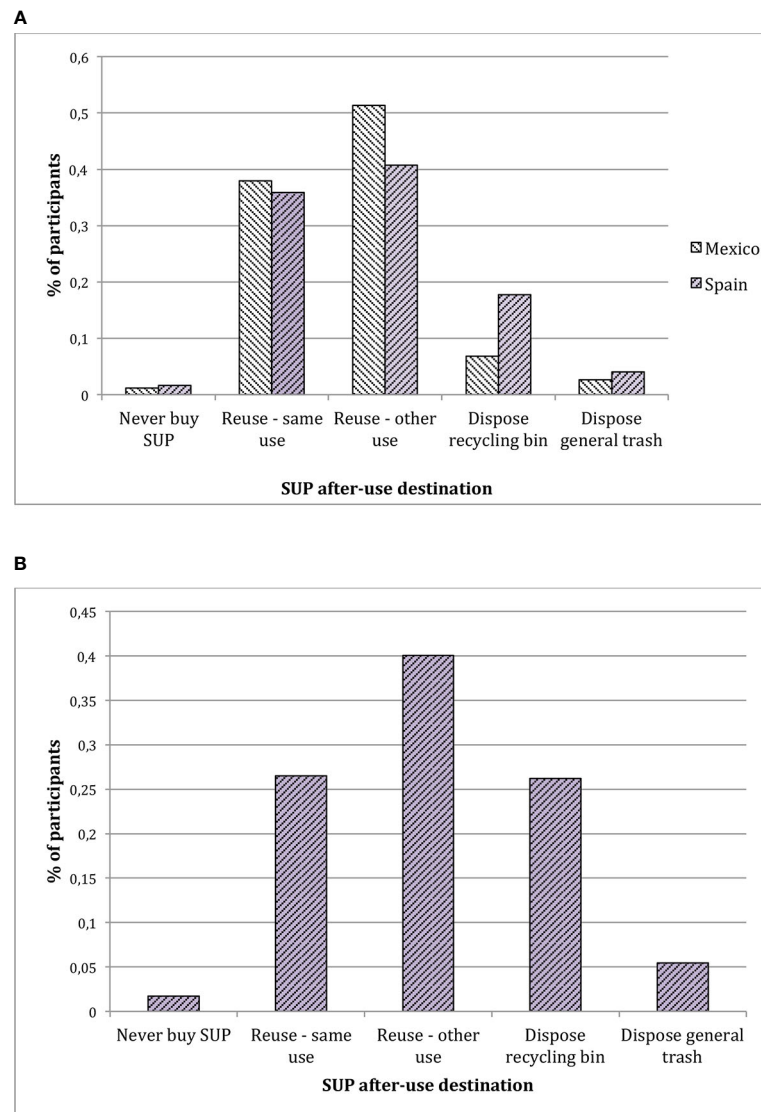
FIGURE 4
Declared after-use destination of single-use plastics in Mexico and Spain samples of students **(A)** and the Spanish non-student sample **(B)**, presented as the proportion of participants choosing each option.

and with the intention to recycle in Mexican students (Supplementary Table 3).

For their different characteristics and significant differences regarding environmental variables, multivariate multiple regression models were run on the three samples separately. Significant multicollinearity could be discarded, because the variable inflation factors were small, from very low V = 1.001 to low V = 1.538.

The results are summarized in Table 3, and the statistical details are provided as Supplementary Material. In the sample of Spanish non-students (Supplementary Table 4), the model identified three variables that predict significantly intended

SUP reduction (Table 3): feeling responsible for the sea, age (the older the more intention to reduce SUP), and gender (female with more intention to reduce SUP). Feeling responsible for the sea also significantly predicted the intention to recycle (together with age but not with gender) and the intention to buy eco-friendly products (together with gender). In all the cases, the level of significance was very high (Supplementary Table 4). None of the independent variables examined predicted the actual reduction of SUP bags or SUP bottle consumption in this sample. However, the educational level (the higher the more) and sea frequentation predicted significantly and positively actual recycling behavior ($t = 2.42$
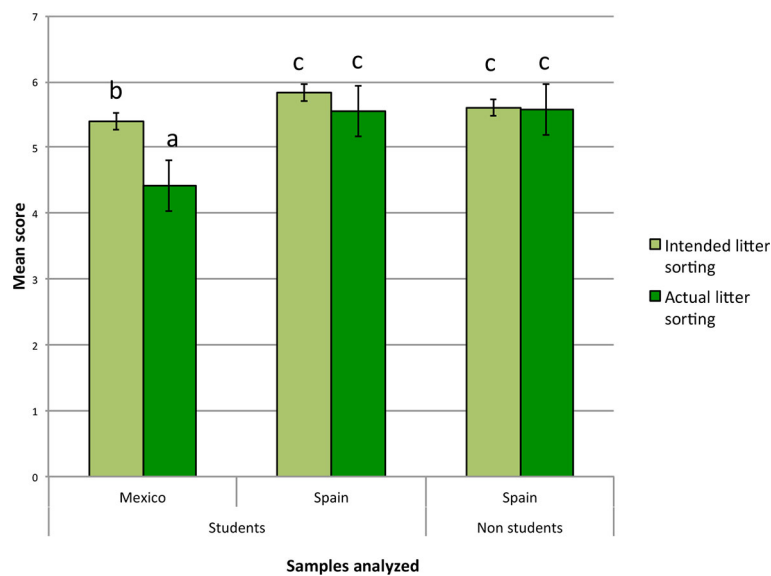
FIGURE 5

Mean score of intended and actual litter sorting, indicating the results of the *post-hoc* tests. Standard error as capped bars.

with $p = 0.016$ and 2.16 with $p = 0.03$; Supplementary Table 4). Personal income did not predict any of the pro-environmental behavior variables considered in this study.

In the Mexican students (Supplementary Table 5), the model identified two main predictor variables: gender and feeling of

responsibility for the sea. As in the Spanish sample of non-students, feeling responsible for the ocean predicted significantly the three behavioral intentions examined (Table 3), with the three regressions being highly significant (Supplementary Table 5). Gender predicted reduced use of plastic bottles,

TABLE 3 Summary of significant predictor variables of pro-environmental behaviors found from multivariate multiple regression models in the three samples analyzed.

		Sea frequentation	Feeling responsible for the sea	Gender	Age	Education	Income
Mexican students	Intention to reduce SUP		X	X			
	Intention to buy eco-friendly		X	X			
	Intention to recycle	X	X				
	Reduced SUP bags						
	Reduced SUP bottles			X			
	Recycling behavior						
Spanish students	Intention to reduce SUP		X	X			
	Intention to buy eco-friendly		X				
	Intention to recycle		X				
	Reduced SUP bags						
	Reduced SUP bottles						
	Recycling behavior	X					
Spanish non-students	Intention to reduce SUP		X	X	X		
	Intention to buy eco-friendly		X	X			
	Intention to recycle		X		X	X	
	Reduced SUP bags						
	Reduced SUP bottles						
	Recycling behavior	X					

Significant predictors are marked with X. Shaded squares mean not tested for lack of variation of these parameters in student samples.
SUP, single-use plastics.

intention to reduce SUP, and intention to buy ecological products. In addition, sea frequentation predicted the intention to recycle ($t = 2.19$, $p = 0.03$; Supplementary Table 5).

The model gave similar but not identical results in the samples of Spanish students (Supplementary Table 6). Again, the feeling of responsibility for the ocean was a significant predictor of the three pro-environmental behavior intentions (Table 3). Sea frequentation predicted the actual recycling behavior, as in Spanish non-students. The main difference was a relatively low predictive value of gender, which in this case predicted significantly only the intention to reduce SUP, $t = 3.12$ with $p = 0.002$ (Supplementary Table 6, Table 3).

From the results above, the three samples had in common gender and the feeling of responsibility as significant predictor variables of pro-environmental behavior intention. Sea frequentation predicted recycling behavior. Gender was also a predictor of actually reduced consumption of SUP bottles. Thus, we focused on these variables to examine the predicted hypothetic model and test mediation effects in the whole sample.

The pairwise correlations between these variables are shown in Supplementary Table 7. Strong positive correlations between the feeling of responsibility for the ocean and intended pro-environmental behaviors, found separately for each sample, were indeed confirmed, as well as positive correlations between pro-environmental behavior intentions and the corresponding actual behaviors. These correlations were highly significant in all the cases (Supplementary Table 7).

After Bonferroni's correction, sea frequentation was positively correlated with recycling behavior ($r = 0.21$, $p << 0.001$) and negatively with reduced SUP bottle consumption ($r = -0.13$, $p << 0.001$) (Supplementary Table 7). This result would suggest a negative effect of sea frequentation in the reduction of SUP, opposite to its effect on recycling.

Gender was significantly and positively correlated with the responsibility for the sea ($r = 0.124$, $p < 0.001$); logically, it was not associated with sea frequentation (Supplementary Table 7). As in each sample separately, gender was correlated with the three pro-environmental intentions and also with reduced SUP bottle consumption ($r = 0.113$, $p < 0.001$; Supplementary Table 7).

Both intended SUP reduction and intended eco-friendly purchase were significant mediators between gender and reduced bottle consumption (Supplementary Table 8, mediations #1 and #2). In other words, women would intend a higher SUP reduction and eco-friendly consumption than men, and those intentions (but not so much being a woman) predict a lower consumption of plastic bottles in our study (Supplementary Table 8).

These relationships and the differences between countries, representing social norms, can be visually summarized as presented in Figure 6. Numerical results are shown in Supplementary Table 9. In the top part of the figure, pro-environmental social norms (which are different between countries in our study; i.e., they would explain, at least

partially, the effect of the country) increase significantly both intended and actual behaviors of reducing and recycling SUP. Other factors, like older age and higher educational level in Spanish non-students, will also influence sustainable SUP consumption.

In the bottom part of Figure 6, we see that the actual reduction of SUP bottles is significantly influenced by gender, mediated by the intentions of reducing SUP and purchasing eco-friendly products (Supplementary Table 8). Gender does not influence significantly actual and intended recycling behavior in this study.

On the left of Figure 6 is represented the emotional component of marine citizenship—feeling responsible for the ocean—which will increase significantly pro-environmental intentions. This intention will in turn increase the actual reduction and recycling of SUP bags and bottles (Supplementary Table 9B). On the right of Figure 6, we find sea frequentation, which increases significantly recycling behavior. The negative effect of sea frequentation on the consumption of SUP bottles suggested by pairwise correlations disappears when the effect of the country (social norms) is controlled in a multivariate multiple regression approach (Supplementary Table 9).

4. Discussion

The results of this study point to significant, positive relations between two components of marine citizenship (sea frequentation and the feeling of responsibility for the ocean) and pro-environmental behaviors (reduced consumption of SUP bags and bottles and recycling). The feeling of responsibility (in this case perceived personal harm to the ocean) predicted the intention to reduce SUP, buy eco-friendly products, and recycle, while sea frequentation predicted actual recycling behavior. These results would support the model of responsible environmental behavior (Hines et al., 1987) because personal responsibility is a key trait of environmentally responsible behavior intention.

The results supported only partially Hypothesis I because only behavior intentions about SUP were predicted from the responsibility for the sea, not actual behaviors. In their work about the perception of the ocean's microplastics, Yoon et al. (2021) found that feelings of guilt about the ocean predicted pro-environmental behavior intentions. Their result was similar to ours in the sense that the question employed here to measure the feeling of responsibility for the ocean (one of the items employed by Yoon et al., 2021, to measure feelings of guilt) also predicted behavior intentions.

Our study went further exploring the actual behavior. In clear contrast with the emotional component of marine citizenship, sea frequentation seems to act more directly on behaviors rather than on behavioral intention. Going frequently
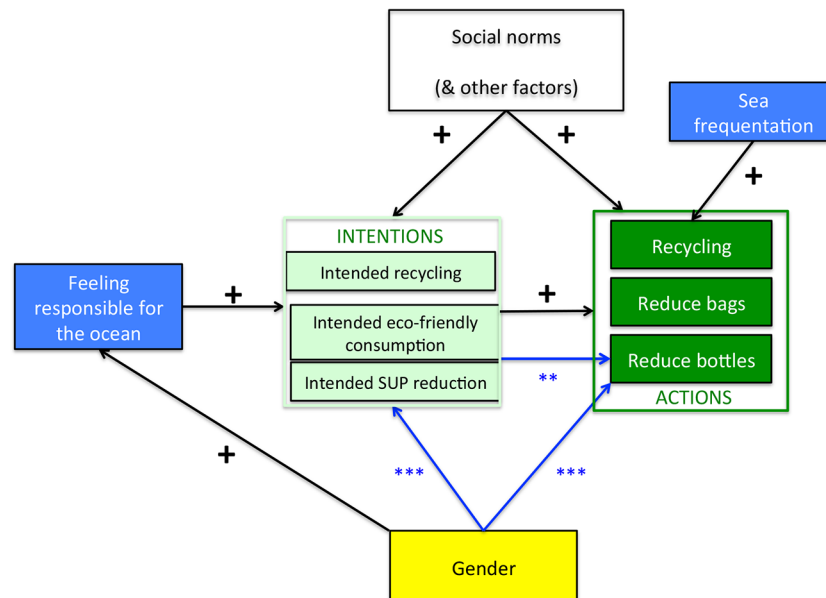
FIGURE 6
Schematic representation of the main significant relationships between marine citizenship components (sea frequentation and feeling responsible for the ocean, in blue boxes), pro-environmental intentions (light green), and behaviors (dark green) found in this study. Mediation effects are marked with blue arrows and direct effects with black arrows. **p < 0.01; ***p < 0.001.

to the sea predicted recycling behavior in our study, which, together with significantly predicted recycling behavior from responsibility for the sea, supported Hypothesis IV. Pro-environmental litter treatment has been associated with beachgoers' awareness in other studies (Slavin et al., 2012; Rayon-Viña et al., 2018); our results would point in the same direction in samples from Mexico and Spain.

Counterintuitively, sea frequentation was correlated with *higher* consumption of SUP bottles when the whole sample was analyzed (Supplementary Table 5). This effect could be explained by the difference between countries since Spanish students frequented more the sea (which is circumstantial) *and* consumed more plastic bottles than Mexican students. Hypothesis III predicted differences between countries for SUP consumption intention and SUP consumption. It was fully confirmed in our study, where Mexican students clearly adopted more pro-environmentally behaviors than surveyed Spanish students of a similar age. The effect of social norms here deduced from different policies (bans and levies in Mexico, only levies in Spain) and opinions about SUP bans (IPSOS/Plastic Free July, 2022) would explain this difference and support other studies where social norms are essential for SUP consumption behavior (Jia et al., 2019; Jacobsen et al., 2022). Heidbreder et al. (2019) highlighted social norms and habits as major barriers to reducing SUP consumption; these barriers would be higher in Spain than in Mexico.

Social norms and habits would also explain the difference between Mexican and Spanish respondents regarding recycling behavior. In this case, as expected in Hypothesis IV, recycling was significantly more frequent in Spain than in Mexico. Again, the different recycling habits and policies in Spain (Escario et al., 2020; Gibovic and Bikfalvi, 2021) and Mexico (Munoz-Melendez et al., 2021) would explain the observed differences.

Supporting Hypothesis II, several demographic factors predicted pro-environmental behavior. Gender influenced significantly many variables in this study, and the direction was the same in the Mexican and Spanish samples. The first variable of importance where gender was significant was the own feeling of responsibility for the ocean, which was higher in women than in men. This result supported other studies like Guest et al. (2015) and García-Gallego et al. (2021), where women valued the ocean more than did men. Moreover, in all our samples, being a woman predicts more environmental-friendly behaviors, mediated or not by behavior intentions, than being a man. This happened in Mexico and Spain. Our results would support those obtained regarding more pro-environmental behaviors regarding plastics in women, found in Spain (Escario et al., 2020) and other countries (Slavin et al., 2012; Owusu et al., 2013; Dilkes-Hoffman et al., 2019b; Nguyen et al., 2022). This result contradicted Rayon-Viña et al. (2018), who found that men take more action against litter. In the Spanish sample of non-students, older age and a higher

educational level also significantly predicted SUP consumption and recycling. Our results were compatible with many other studies (e.g., Bator et al., 2011; Slavin et al., 2012; Escario et al., 2020), although not with the negligible influence of sociodemographic factors found by Walker et al. (2021) in Canada, or with more reduced use of SUP in younger South Africans (O'Brien and Thondhlana, 2019).

It is important to remark that the vast majority of the respondents in this study adhered to an R strategy for SUP after-use, although only a few opted to refuse SUP bags and bottles. The main reasons declared by respondents were forgetting reusable goods and reusability, plus the lack of alternatives in the case of SUP bottles (see Figure 3). These are quite commonly alleged causes of SUP use. In their review, Heidbreder et al. (2019) reported studies where the main reason to use plastic bags is forgetting one's own reusable bag. This was the main reason declared by Spanish respondents in our study too. In Mexico, instead, reusability was the first cause of SUP use. Like in the Mexican sample, reusability—together with convenience and easy availability—was one of the main reasons for the use of plastic bags in South Africa (O'Brien and Thondhlana, 2019). A lack of alternatives has also been reported as an important barrier to SUP reduction (Heidbreder et al., 2020).

An interesting difference between students and non-students in plastic bottle consumption was found. Non-students used fewer plastic bottles than students did (Figure 2). Habits that are the main barriers to the individual reduction of SUP consumption (Wiefek et al., 2021) could explain this difference. Young people are high consumers of bottled water (e.g., Jovarauskaitė et al., 2020) and would consequently purchase more SUP bottles than older people do when they forget (or do not find) reusable ones. However, being female was a predictor of reduced use of plastic bottles, mediated significantly by the intention to act sustainably (both intended SUP reduction and use of eco-friendly alternatives). This is consistent with differences between genders in bottled water consumption drivers found from Hong Kong and Macau (Qian, 2018) to Brazil (Pacheco et al., 2018) and indeed supports the presence of gender in the list of factors intervening in sustainable behaviors.

This study has some limitations. One is that in our survey we did not test essential elements of Ajzen and Fishbein (1980) and Kollmuss and Agyeman (2002) models, like knowledge and attitudes about SUP. Our intention was to explore the possible use of marine citizenship for encouraging consumers to reduce SUP, not to create a new model. Another possible limitation was that the online survey used a single model of a questionnaire, not balancing the blocks and questions. Finding the items that measure behavior intention right after the question about the personal concern for the ocean (in Block C; see Table 1) perhaps elicited somewhat biased responses toward behavior intentions. However, this possible limitation

does not affect the comparison between Mexico and Spain, the results related to actual behavior, or the predictive value of independent variables.

4.1 Applications to single-use plastics control

The main novelty of this study was to put together components related to marine citizenship and R behaviors related to plastics like reducing SUP consumption and recycling. Other authors like Yoon et al. (2021) found that the specific reference to the harms caused by plastics to the ocean (microplastics in their study) was useful to increase the intention to adopt pro-environmental behaviors. Enhancing marine awareness has been proposed in other studies as a way to improve serious problems of coastal littering and biopollution in Spain (Rayon-Viña et al., 2022). The concern about the ocean could be employed in public awareness campaigns to convince citizens to refuse SUP, something that is still infrequent in the Mexican and Spanish groups analyzed in this study.

Ocean literacy is essential here. Ocean literacy could be defined as the individual understanding of how the ocean affects people and how people affect the ocean (Costa and Caldeira, 2018; Worm et al., 2021). It is included within the Sustainable Development Goal 14—*Life below water*—in the United Nations Decade of Ocean Sciences for Sustainable Development 2021–2030 (UNESCO-IOC, 2021). In educational settings, ocean literacy research has revealed that students' understanding of the ocean is significantly correlated with their environmental attitudes (Lin et al., 2020). Although ocean literacy is not usually included among the curricular contents or in the usual teaching practices—ocean literacy programs are often considered non-formal education (Ferreira et al., 2021)–its inclusion in all educational contexts should be a priority (Worm et al., 2021). We support these views for a conscious, informed concern about the ocean in the population.

The concern about the ocean was also significantly related to the intention to buy eco-friendly products. Plastic-free alternatives are preferred for plastic mitigation in many studies (Dilkes-Hoffman et al., 2019a; O'Brien and Thondhlana, 2019; Gill et al., 2020). The use of ecological alternatives could also be encouraged by using marine citizenship as a central topic in informative campaigns. It has to be recalled that the concern for the sea does not depend on its proximity to it. These two variables were not correlated in our study, and the value assigned to ocean resources and diversity is not different in coastal and inland regions in other studies (García-Gallego et al., 2021). Thus, campaigns based on ocean conservation are likely similarly effective in regions located at different distances from the sea.

Public awareness through education programs reduces marine debris, creating a sense of environmental responsibility (Bravo et al., 2009); thus, civic public education could be another strategy to reduce SUP use where bans are not well accepted or are still far from implementation (Wahinya and Mironga, 2020; Borg et al., 2022). Civic education addresses competencies such as civic and political knowledge and skills, sense of responsibility, and citizen active participation (Schulz et al., 2018). Although in citizenship education teachers' beliefs may prioritize some of its content (Reichert and Torney-Purta, 2019), civic learning promotes capacities to gather and analyze available information to make informed decisions. Taking SDG 14 as a reference (which seeks to prevent and reduce marine pollution of all kinds), civic public education can provide the basic concepts, procedures, and attitudes needed to reduce SUP, regardless of the legislative initiatives that a Government may adopt. From our results, including the emotional components of marine citizenship in public education campaigns could improve their effect regarding not only SUP reduction but also other R behaviors like recycling. These behavioral changes would surely reduce the current plastic and microplastic pollution in the ocean.

5. Conclusions

This study showed that feeling responsible for the ocean was a significant predictor of the intention to reduce SUP consumption in Mexican and Spanish student samples and Spanish non-students. A higher SUP reduction in Mexican than in Spanish students was consistent with stricter SUP bans (thus social norms favorable to SUP reduction) in Mexico than in Spain. Gender was a significant mediator between the intention to reduce SUP consumption, the intention to buy eco-friendly products, and the actual consumption of plastic bottles. Sea frequentation did not influence significantly SUP consumption in this study.

Recycling behavior (specifically litter sorting) was more frequent in Spanish than in Mexican students and was significantly predicted by sea frequentation, and recycling intention was predicted from the feeling of responsibility for the ocean.

Age and education also influenced pro-environmental behaviors in Spanish non-students, with older age promoting the intention to reduce SUP and recycling, and a higher level of education intended to recycle.

The results of this study suggest that enhancing the emotional components of marine citizenship could promote the reduction of SUP consumption and increase alternative eco-friendly choices. This effect would be obtained even in populations living from the sea or visiting the coast infrequently.

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.

Ethics statement

The studies involving human participants were reviewed and approved by Committee of Research Ethics of Asturias Principality, reference CEImPA:2021.116. The patients/participants provided their written informed consent to participate in this study.

Author contributions

EG-V: conceptual design, data acquisition, data analysis, article writing. CG-A: conceptual design, data acquisition. MC, ED, and NR: data acquisition. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2022.941694/full#supplementary-material

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