Journal of STEAM Education
Journal of Science, Technology, Engineering, Mathematics and Art Education
2023, Jun. (Issue: 2, Volume: 6)

Environmental Literacy for Waste Management in an Academic Community: A case study

Hélder Spínola[1]

Research Article

Article History

Received: 9 June 2022

Received in revised form:

3 Jan. 2023

Accepted: 10 Jan 2023

Published: 1 Jun 2023

ABSTRACT

Excessive waste production has been one of the main causes for the environmental imbalances caused by humanity. Minimize this problem demands for the promotion of the environmental literacy on waste management and, to do that, an investment in more and better environmental education. However, first, we need to know the level of environmental literacy each community has developed so far and what is missing to reach an adequate performance. As so, environmental education could be conveniently oriented with a most effective approach and with an adequate match between the defined goals and those really needed. Present study evaluates environmental literacy for waste management in the academic community of the University of Madeira (Portugal), characterizing knowledge, attitude and behaviour among students, teachers, and other staff. Results show a good performance for knowledge, even better for attitude, but only sufficient for behaviours. Additionally, it identifies those knowledges and behaviours that need to be prioritized in future environmental education approaches, besides clarifying that the effectiveness on implementing waste management best practices is most dependent on social, physical, and organizational transformations than on knowledge and attitude.

Keywords: Environmental education; Environmental literacy; Portugal; University of Madeira; Waste management.

[1]Research Centre in Education, University of Madeira, Penteada Campus. 9000-105 Funchal – Portugal, Phone ++351 291 291705000; E-mail: hspinola@uma.pt 0000-0002-6455-1595

Spínola, H. (2023). Environmental literacy for waste management in an academic community: A case study. *Journal of STEAM Education, 6*(2), 119-142. http://doi.org/10.55290/steam.1128303

INTRODUCTION

Since the 1970's, humanity has been exploiting resources and emitting pollution much far beyond the Planet's biocapacity. The human ecological footprint is now much bigger than the Planet Earth (75% bigger), and we are facing an ecological crisis and a global climate change due to our inability to respect the natural balance (Lumsden, 2018). Waste production accounts for an important part of our ecological footprint due to the material and energy consumption it represents, as well as its carbon dioxide emissions and other pollution it makes (Kissinger et. al., 2013). Each year, about 7–9 billion tonnes of waste are produced globally (Wilson & Velis, 2015), being 2 billion tonnes of it Municipal Solid Wastes (MSW), a category that includes valuable materials (glass, paper, plastic, metals, organics, etc.) but, at the same time, with a great negative impact on the environment if not properly managed (Chen et. al., 2020). Since the past 60 years, the production of MSW tripled, and it is estimated that it could increase more than 150% until 2050 (Chen et. al., 2020).

If not conveniently managed, wastes can result in serious pollution problems. For example, it was estimated that Ocean Atlantic hold 17-47 million tonnes of plastic (Pabortsava & Lampitt, 2020), and that the intake of microplastics, through the food we eat and the water we drink, may represent in average 280 microparticles of plastic per day (Dalberg Advisors, 2019), being already present in the human blood (Leslie et. al., 2022). Despite the implementation of waste collection systems around the world, littering still is a widespread problem with negative impacts for the environment and human health. Additionally, even when they are collected, the amount that is sent for recycling does not reach 20% globally (Chen et. al., 2020).

The 12sd United Nations Sustainable Development Goal (SDG12) intends to 'ensure sustainable consumption and production patterns', which require proper waste management. SDG12 defines several targets to be achieved by 2030, namely a sustainable management and efficient use of natural resources, halve the per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses, and, among other, substantially reduce waste generation through prevention, reduction, recycling, and reuse (Department of Economic and Social Affairs, n.d.a). SDG12 also included a target that should be achieved by 2020: an environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment; but so far it is clear that has not been achieved. Additionally, the 14th SDG (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) defines as one of its targets to prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, by 2025 (Department of Economic and Social Affairs, n.d.b). Considering the short schedule, we have to achieve this ambitious goals and targets and how far we are from them, it is quite evident that we need to boost environmental literacy for waste management among our citizens and societies, moving away from a consumer society and approach environmental culture and circular economy. First step is, after decades of environmental education (Spínola, 2014), to know where we are and how far we still have to go.

Environmental literacy is the primary goal of environmental education, being a prerequisite to achieve environmental quality and, among others, to have an adequate waste management (Disinger & Roth, 1992). Besides knowledge, environmental literacy also includes affective dispositions and cognitive skills and abilities, together with practices that could improve our performance on environmental sustainability (Hollweg et al., 2011). Nevertheless the above simplification, environmental literacy hold a complex structure, namely because, among others, it should include: knowledge on physical, ecological, social, cultural and political systems; sensitivity, attitudes, personal responsibility and motivation; competencies on identifying, analyse, investigate, evaluate and resolve environmental issues; and environmentally responsible behaviour with practices in eco-management, persuasion, consumer/economic action, political action and legal action (Cook & Berrenberg, 1981; Hollweg et. al., 2011; Hungerford & Volk, 1990; Stern, 2000). However, to evaluate environmental literacy, such a complex structure makes difficult to include all the components in a single assessment. To overcome that problem, knowledge, attitude and environmentally responsible behaviour were identified as the major components to be included in the surveys (Hallfreðsdóttir, 2011; Igbokwe, 2012; Krnel & Naglič, 2009; Kuhlemeier et. al., 1999; McBeth & Volk, 2010; Pe'er et. al., 2007).

Since the past decades, a comprehensive effort on environmental education was put in place. Evaluating environmental literacy in a group or a context is the best strategy to assess its achievements and address the need for better practices and strategies. However, in Portugal and worldwide, environmental education lacks evaluation, working mainly in the dark, and since the ecological crisis is getting worse, namely the problems that results from a lack of an adequate waste management, it is legitimate to question its effectiveness (Blumstein & Saylan, 2007; Schmidt et al., 2010). In Portugal, environmental education curricular integration has been centred in a specific group of classical disciplines, namely Natural Sciences, Geography and Biology (Tracana et al., 2012), and suffers from ‘infantilization’, being mostly focused on younger students, with entertaining and recreational pedagogical strategies (Schmidt et al., 2010; Schmidt et al., 2011). As students grow, they are less involved in environmental education projects and curriculum (Schmidt et al., 2011), being symptomatic that, in Portugal, the main environmental education program (the Eco-Schools Program) involves about 66% of students from basic education and only 2.2% of those from higher education. From the scarce information available for higher education in Portugal, it seems that the fragilities found for other levels of the educational system may be herein exacerbated (Amador et al., 2015; Azeiteiro et al., 2015; Caeiro et al., 2020; Farinha et al., 2019; Farinha et al., 2018; Farinha et al., 2017; Filho et al., 2017; Fonseca et al., 2018; Leite & Dourado, 2015; Otto et al., 2019; Spínola, 2012). In fact, a study that includes Portugal showed that the top five obstacles to implementing sustainability at universities are the lack of awareness and concern (Filho et al., 2017). Also, a case study in Portugal, on a master’s program in Environmental Citizenship and Participation, reveals inconsistency between theory and praxis on its education for sustainable development contributions, asking for curricula improvements (Amador et al., 2015). Additionally, the analysis of the Portuguese public universities plans and strategies shows that higher education institutions were not sufficiently engaged in education for sustainability and that the subject is not integrated into a whole-institution approach (Farinha et al. 2019).

As so, considering the strong influence that graduated citizens could have in societies, that about half of young people attends this level of education, and that higher education in Portugal and overseas could be falling behind its responsibilities in promoting environmental literacy (Farinha et al., 2017; Farinha et al., 2018; Spínola, 2012), it is of utmost importance to know the environmental literacy present in this level of education in order to better define and implement environmental education programs and strategies. Besides the relevance for the Portuguese reality, the evaluation of the environmental literacy on particular contexts is also of international interest. In fact, the enrichment of the set of case studies on environmental literacy, in waste management or in general, is a contribution for benchmarking, to understand its global evolution, and to distinguish context-dependent influences from those that could be generalized.

Purpose of the research

Thus, as a baseline characterization, understanding and identification of opportunities of improvement for future developments through environmental education approaches, present study intends to characterize the levels of knowledge, attitudes, and behaviours for waste management among students, teachers and other staff at the University of Madeira. As so, the research question was defined as: Which are the levels of waste management environmental literacy on the University of Madeira academic community?

METHOD

Research design

To characterize the environmental literacy (knowledge, attitudes and behaviours) for waste management among students, teachers and other staff at the University of Madeira, an online, cross-sectional, closed-ended, and anonymous quantitative survey questionnaire was self-administered. In February 2019, the access link for the online questionnaire was sent in an e-mail message to all the students (about 3500), teachers (230) and other employees (138) that constitutes the University of Madeira academic community.

Participants

The University of Madeira is a public institution of higher education located in the city of Funchal (Madeira Island- Portugal), with its teaching and research activities concentrated in a single pole, the Penteada Campus. It assumes itself as a centre for the creation, transmission and dissemination of culture, science, and technology at the service of the humanity, and aims to prepare its students to be technically and scientifically competent, cultured, and innovative citizens, acting on the basis of the values of transparency, justice, equality, fraternity and to the sustainable development of the Planet. The University of Madeira is made up of 4 faculties (Arts and Humanities, Exact and Engineering Sciences, Social Sciences, and Life Sciences) and 2 higher schools (Health, and Technology and Management), involving around 3,500 students distributed over 20 degrees, 23 masters, 8 doctorates and 14 Professional Higher Technical Courses. The teaching staff is made up of more than 230 professionals and the institution's operation is supported by the involvement of 138 non-teaching staff. Until this study was carried out, in February 2019, the University of Madeira did not have any formal or systematic

environmental education program, with only a few specific activities included in subjects and courses related to the environment.

Between February and March 2019, after an online questionnaire application at the University of Madeira, 130 answers were collected, mostly from students (92) but also with the contribution of teachers (19) and other staff (19). Among the 92 students, 15 were from Professional Courses, 54 from Graduations (22 from the first year; 13 from the second year, and 20 from the third year), 17 from Masters, and 5 from Doctoral courses (PhD). As so, the total number of respondents allow, for a 95% confidence interval, a margin of error below ±10% (Brace et al., 2016), enough to minimize sampling bias, but ±20% if considering only teachers and other employees.

Data collection tool

An online, cross-sectional, closed-ended, and anonymous quantitative survey questionnaire was developed to address the specific purpose of the present study and considering the reality lived under the University of Madeira campus. After a first version, the questionnaire was given out for revision by other experts and tested on a sample of 20 students. A final revision was done to correct some statements and one question was completely removed since the answers doesn't shown consistency.

With a total of 15 questions focused on the reality of waste management at the University of Madeira Campus, the questionnaire (appendix 1) was organized in three main sections to evaluate knowledge (section 1- 4 questions), attitudes (section 2- 5 questions) and behaviours (section 3- 6 questions). First section, for knowledge, ask respondents to choose the waste they consider worst for the environment, to select the most effective approach to achieve a better waste management, to properly segregate 19 different kinds of waste for recycling, and to select a set of 9 statements that reveals their knowledge on how to reduce waste generation as also their believes on the consequences of littering. For analysis purpose, the answers for each of the 19 wastes items for recycling and the 9 statements on how to reduce waste generation and their consequences from littering were individualized, which increased the knowledge section from 4 to 30 questions. For attitude, in the 2nd section, the questionnaire presents five statements and ask respondents to classify their grade of concordance in a Likert-type scale of five points ranging from totally disagree (1) to totally agree (5). The statements used goes through attitudes towards the amount of wastes produced and its consequences, the possibility of avoiding the use of plastics, and the importance of individual contribution on waste management. Finally, the third section presents six behaviours on recycling, preventing pollution and waste production, and ask respondents to select the frequency they practice them in a Likert-type scale ranging from never (1) to always (5).

The questionnaire was not intended to collect participants' personal data, namely age and gender, only the year and the course level attended by students and identify teachers and other staff among respondents. Despite this option could be seen as a limitation for data interpretation, our choice was based on the fact that, for the sample number we knew we could collect, such data would be statistically irrelevant due to the small sample number for those subgroups. As

so, we opt to keep the questionnaire as short as possible thanking in consideration our research question.

Data analysis

Data collected in the survey were normalized as if all statements were environmentally positive and converted to numeral scores ranging from 1 to 5, for attitude and behavioural domains, and, for knowledge, scored "1" or "0" if answers were correct or incorrect, respectively. Blank responses were scored as missing values. With IBM SPSS statistics software (version 27), reliability (through Cronbach's Alpha) and validity (confirmed by positive and significant Pearson correlations) were evaluated, followed by percentages calculation and test for significant differences. Pearson's correlations (r), and their one-tailed significance, were calculated for each pair of items. As a guideline, a correlation coefficient interval of r=0.10 to 0.29 represents a small positive relationship, a r=0.30 to 0.49 represents a medium positive relationship and a r=0.50 to 1.0 represents a large positive relationship (Pallant, 2007). The Cronbach's Alpha score was 0.665 for Knowledge section, 0.521 for Attitude section and 0.200 for Behaviour section, the latter a very low value that push down to 0.399 the score for the entire measuring instrument. Nevertheless, this low score could be a consequence of the low number of questions used and the lack of correlation between different behaviours (Graham, 2006; Nunnally & Bernstein, 1994). Validity of the instrument were confirmed for 8 of the 15 questions since they show positive and significant ($p<0.05$) Pearson correlations.

RESULTS

Considering total samples, 81.7% of the answers were correct for knowledge, 91.8% agree or totally agree with a positive waste management attitude, and 61.6% perform waste management best practices 'often' and 'always' (Figure 1).

For knowledge, a large majority (higher than 80%) identify plastic as a dangerous waste for the environment (86.9%) and considers that it is worse than glass (97.7%), knows that cigarette buts are not biodegradable (96.9%) and that the lack of bins is not a reason to toss wastes (85.4%), agree that the use of reusable mugs (82.3%) and bringing lunch from home (98.5%) is important to reduce waste production, identifies bottled water consumption (89.2%) and the use of paper towels (85.4%) as resulting in increased waste production, select Reduce, Reuse or Recycle as the most important approach for waste management (97.7%), and knows how to sort for recycling newspapers (99.2%), soda cans (89.2%), plastic bags (96.2%), plastic bottles (98.5%), glass bottles (100%), French fries' package (80.8%), yogurt plastic cups (90%) and banana peels (98.5%) or apple cores (94.6%) (Table 1 and Figure 2). However, in the opposite direction, few on the University of Madeira academic community knows how to correctly dispose paper coffee cups (26.2%) and even broken glass cups (29.2%). Due to the low sample number, only two groups were organized to allow comparisons: Students (n=92) and Teachers and other staff, henceforth treated as Staff (n=38). For knowledge, the comparison between Students (80.7%) and Staff (84.9%) doesn't reach significant differences (p=0.3). Nevertheless, Teachers and other staff show a statistically significant higher prevalence of correct answers for a few specific questions, especially in how to sort wastes, namely Tetra Pak packaging [Students (73.9%) and Staff (89.5%) p=0.003], broken teacups [Students (61.1%) and Staff

(76.3%) p=0.003], metallic caps [Students (64.1%) and Staff (78.9%) p=0.013] paper coffee cups [Students (25.3%) and Staff (28.2%) p<0.001] and dirty napkins [Students (62.9%) and Staff (81.6%) p=0.002], but also identifying plastic as a dangerous waste for the environment [Students (83.7%) and Staff (94.7%) p=0.01] and bottled water as a source of wastes [Students (86.8%) and Staff (97.4%) p=0.006], also knowing that even recycling pollutes [Students (71.4%) and Staff (84.2%) p=0.02], and that tap water in Madeira Island is of good quality [Students (71.4%) and Staff (84.2%) p=0.02] (Table 1). The only exceptions are on the separation of yogurt plastic cups for recycling, with Students (92.4%) showing a higher prevalence of correct answers than Staff (84.2%) (p=0.042), and knowing that reduce, reuse or recycle allows a better waste management [Students (97.8%) and Staff (94.9%) p=0.016].

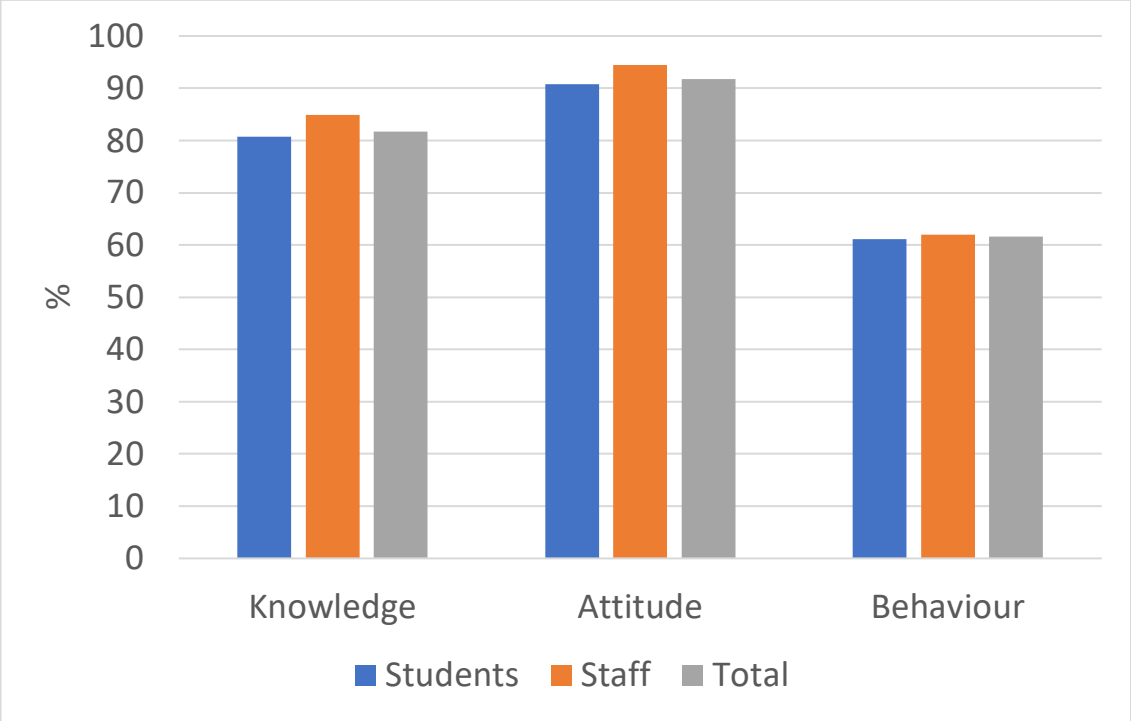

Figure 1. Overall performance on Environmental Literacy for waste management (knowledge, attitude and behaviour). Knowledge- correct answers; Attitude- concordance (agree and totally agree) with a positive waste management attitude; Behaviour- prevalence (often and always) of waste management best practices.

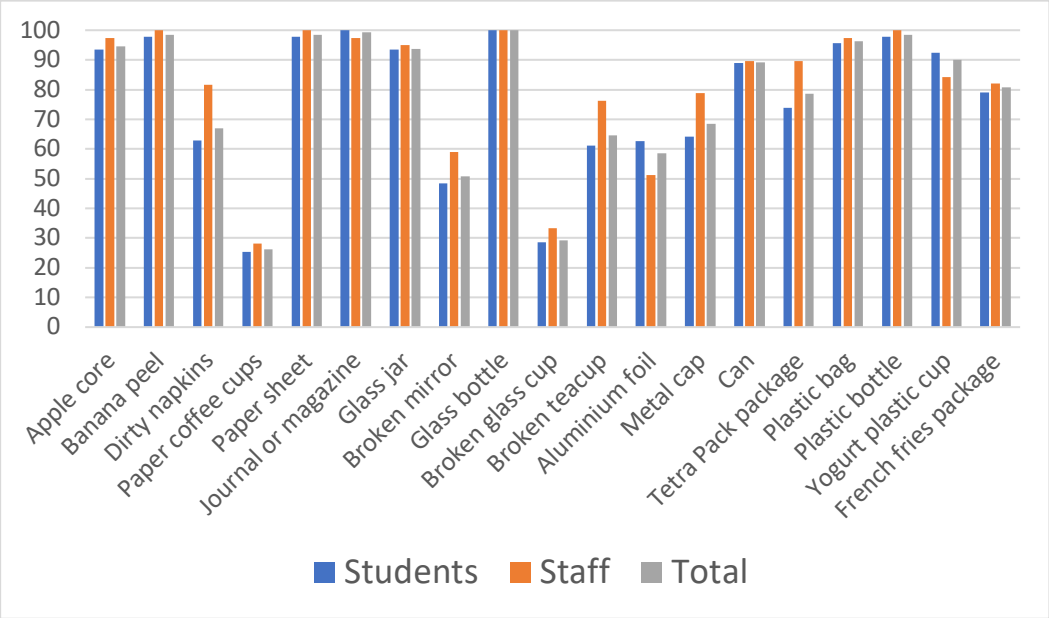

Figure 2. Prevalence of knowledge on how to sort wastes for recycling, or dispose.

On how to sort wastes for recycling, several knowledge's shown positive and significant correlations, being the highest values of Pearson correlation coefficient achieved between the knowledge on how to sort: soda cans and French fries' package ($r=0.461$, $p<0.001$) or Tetra Pak packaging ($r=0.461$, $p<0.001$); plastic bags and plastic bottles ($r=0.494$, $p<0.001$) or paper sheets ($r=0.573$, $p<0.001$); plastic bottles and paper sheets ($r=1$, $p<0.001$); broken teacups and broken glass cups ($r=0.476$, $p<0.001$) or broken mirrors ($r=0.644$, $p<0.001$); broken glass cups and broken mirrors ($r=0.628$, $p<0.001$); and banana peels and apple cores ($r=0.573$, $p<0.001$). Also, despite with lower values, a positive and significant correlation was found between some knowledges' in how to sort wastes for recycling and other types of knowledge, namely: how to sort Tetra Pak packaging and that bottled water consumption produces wastes ($r=0.271$, $p=0.002$), that the lack of bins is not a reason to toss wastes ($r=0.178$, $p=0.044$), that recycling does not prevent all pollution ($r=0.19$, $p=0.031$), that drying hands with paper napkins increases the production of waste ($r=0.233$, $p=0.008$), or that tap water is of good quality ($r=0.366$, $p<0.001$); how to sort a broken teacup and that drinking bottled water increases waste production ($r=0.3$, $p=0.001$), that drying hands with paper napkins increases the production of waste ($r=0.179$, $p=0.045$), or that cigarette butts are not biodegradable ($r=0.214$, $p=0.016$); how to sort a broken mirror and that bottled water consumption produces wastes ($r=0.19$, $p=0.033$) or that recycling does not prevent all pollution ($r=0.236$, $p=0.008$); how to sort an apple core and that the reusable cups reduce the production of waste ($r=0.209$, $p=0.019$); how to sort a dirty napkin and that garbage on the floor doesn't result from the lack of dustbins ($r=0.23$, $p=0.01$) or that tap water is of good quality ($r=0.268$, $p=0.002$); how to sort a glass jar and that bringing lunch from home decreases the production of waste ($r=0.369$, $p<0.001$); how to sort a French fries package and that recycling does not prevent all pollution ($r=0.187$, $p=0.034$), that bringing lunch from home decreases the production of waste ($r=0.185$, $p=0.036$), or that cigarette butts are not biodegradable ($r=0.191$, $p=0.031$); and how to sort a yogurt plastic cup and that tap water is of good quality ($r=0.187$, $p=0.034$). Besides sorting wastes, others

knowledge's also correlate significantly, namely knowing: that plastic is the worst for the environment and that plastic bottles are worst for the environment than glass ones (r=0.396, p<0.001); that drinking bottled water increases waste production and that recycling does not prevent all pollution (r=0.285, p=0.001), or that tap water is of good quality (r=0.225, p=0.01); that garbage on the floor doesn't results from the lack of dustbins and that tap water is of good quality (r=0.185, p=0.038): that reusable cups reduces the production of waste and that cigarette butts are not biodegradable (r=0.204, p=0.021) or that tap water is of good quality (r=0.183, p=0.038).

Table 1. Prevalence of knowledge on how to sort wastes for recycling, or dispose.

Knowledge		Students	Staff	Significance	Total
Knows that plastic is worst for the environment		83.7%	94.7%	p=0.010	86.9%
Knows that reduce, reuse or recycle allows a better waste management		97.8%	94.9%	P=0.016	97.7%
Knows how to sort…	Apple core	93.4%	97.4%	p=0.137	94.6%
	Banana peel	97.8%	100%	p=0.076	98.5%
	Dirty napkins	62.9%	81.6%	p=0.002	66.9%
	Paper coffee cups	25.3%	28.2%	P<0.001	26.2%
	Paper sheet	97.8%	100%	p=0.076	98.5%
	Journal or magazine	100%	97.4%	p=0.845	99.2%
	Glass jar	93.4%	94.9%	p=0.375	93.8%
	Broken mirror	48.4%	59.0%	p=0.143	50.8%
	Glass bottle	100%	100%	-	100%
	Broken glass cup	28.6%	33.3%	p=0.284	29.2%
	Broken teacup	61.1%	76.3%	p=0.003	64.6%
	Aluminium foil	62.6%	51.3%	p=0.893	58.5%
	Metal cap	64.1%	78.9%	p=0.013	68.5%
	Can	89.0%	89.7%	p=0.458	89.2%
	Tetra Pack package	73.9%	89.5%	p=0.003	78.5%
	Plastic bag	95.6%	97.4%	p=0.295	96.2%
	Plastic bottle	97.8%	100%	p=0.076	98.5%
	Yogurt plastic cup	92.4%	84.2%	p=0.042	90.0%
	French fries package	79.1%	82.1%	p=0.358	80.8%
Knows that drinking bottled water increases waste production		86.8%	97.4%)	p=0.006	89.2%
Knows that the lack of bins is not a reason to toss wastes		84.6%	87.2%	p=0.357	85.4%
Knows that reusable cups reduce the production of waste		80.2%	87.2%	p=0.159	82.3%
Knows that plastic bottles are worse for the environment than glass ones		96.7%	97.4%	p=0.204	96.9%
Knows that that even recycling pollutes		71.4%	84.2%	p=0.020	74.6%
Knows that drying hands with paper napkins increases the production of waste		86.8%	82.1%	p=0.756	85.4%
Knows that bringing lunch from home reduce waste production		97.8%	100%	p=0.076	98.5%
Knows that cigarette butts are not biodegradable		96.7%	97.4%	p=0.412	96.9%
Knows that tap water is of good quality		71.4%	84.2%	p=0.020	74.6%
Total		80.7%	84.9%	p=0.300	81.7%

The levels of concordance with the statements selected to evaluate attitudes towards waste management show high pro-environmental levels (Table 2). More than 90% agree or totally agree that waste production is currently excessive (95.4%), that pollution due to waste production is not a minor issue concern (91.6%), that abandoned garbage makes places unpleasant (96.9%), and that the contribution of each one of us is essential for a proper waste management (97.7%). With lower levels of concordance is the idea that, despite they are light and practical, plastic packaging can be avoided (77.5%). As for knowledge, there are no significant differences between Staff and Students regarding overall Attitude [Students (90.8%) and Staff (94.4%) p=0.231], but for three of the five statements the level of concordance is significantly higher in Staff: concern with the pollution originated from waste [Students (87.9%) and Staff (100%) p<0.001]; that abandoned garbage makes places unpleasant [Students (95.6%) and Staff (100%) p=0.0204]; and that contribution of each one of us is essential for a proper waste management [Students (96.7%) and Staff (100%) p=0.039]. For attitude, some positive and significant correlations were found between the concordance of the following statements: 'waste production is currently excessive' with 'despite they are light and practical, plastic packaging can be avoided' (r=0.18, p=0.041); 'the pollution due to waste production is not a minor issue' with 'the contribution of each one of us is essential for the proper waste management' (r=0.198, p=0.024); and 'abandoned garbage makes places unpleasant' with 'the contribution of each one of us is essential for the proper waste management' (r=0.397, p<0.001).

Table 2. Levels of concordance (agree or totally agree) with adequate attitudes towards waste management among Students and Staff.

Attitudes	Students	Staff	Significance	Total
Waste production is currently excessive	95.6%	94.9%	p=0.575	95.4%
Pollution due to waste production is not a minor issue concern	87.9%	100%	P<0.001	91.6%
Abandoned garbage makes places unpleasant	95.6%	100%	p=0.020	96.9%
Contribution of each one of us is essential for a proper waste management	96.7%	100%	p=0.039	97.7%
Despite they are light and practical, plastic packaging can be avoided	78.0%	76.9%	p=0.566	77.5%
Total	90.8%	94.4%	p=0.231	91.8%

Despite waste management best practices show a lower prevalence than the levels of knowledge and attitudes, the enquiry identifies some with high incidence, namely separating wastes for recycling (75.4%), and never toss wastes (99.2%) and cigarette buts (87.5%, among smokers), considering the prevalence of 'always' and 'often' (Table 3). On the contrary, other behaviours

shows prevalence much lower than 50%, as 'never' or 'rarely' use paper towel to dry hands (38.5%), 'always' or 'often' using reusable cups at the coffee machine (23.5%, among coffee machine users) and 'never' or 'rarely' drinking bottled water (45.3%). For 'often' and 'always' prevalence's, overall waste management best practices were similar between Students (61.1%) and Staff (62.0%) (p=0.403) and, at specific behaviours, none is statistically different between both groups. Additionally, only a pair of behaviour shows a significant positive correlation: using reusable cups in coffee machines and ashtrays for cigarette butts (r=0.287, p=0.001), among smokers and coffee machine users.

Table 3. Prevalence of waste management best practices among Students and Staff.

Behaviours	Students	Staff	Significance	Total
Always and often separating wastes for recycling	72.5%	82.1%	p=0.115	75.4%
Never toss wastes	98.9%	100%	p=0.157	99.2%
Never toss cigarette buts*	86.5%	90%	p=0.370	87.5%
Never or rarely use paper towel to dry hands	38.5%	41.0%	p=0.375	38.5%
Always or often using reusable cups at the coffee machine**	25.0%	12.8%	p=0.820	23.5%
Never or rarely drinking bottled water	45.1%	46.2%	p=0.479	45.3%
Total	61.1%	62.0%	p=0.403	61,6%

*Among smokers, n=56 (Students n=37; Staff n=19)

**Among coffee machine users, n=85 (Students n=60; Staff n=25)

The correlations between Knowledge, Attitude and Behaviour on waste management shows small significant results ($r<0.326$), mostly positive but same negative (data not shown). Six significant positive correlations ($r= 0.147 – 0.244$, $p<0.05$) were found between Knowledge and Attitude, mostly on knowledge on how to sort unusual materials and all the attitude statements. For example, knowing how to sort a broken teacup and a metal cap correlates with the concordance that 'contribution of each one of us is essential for a proper waste management' (r=0.174, p=0.025 and r=0.187 p=0.017, respectively) and knowing that plastic is worst for the environment correlates with the concordance that 'abandoned garbage makes places unpleasant' (r=0.244 p=0.003). Fifteen significant correlations were found between Knowledge and Behaviour, 7 negative and 8 positive ($r<0.326$), mostly with the behaviours of separating wastes for recycling and using reusable cups at the coffee machine. Always and often separating wastes for recycling correlates positively with knowing how to sort a plastic bottle (r=0.157 p=0.038), a banana peel (r=0.160 p=0.035), an apple core (r=0.161 p=0.036), and a paper sheet (r=0.157 p=0.038), but negatively with knowing how to sort a Tetra Pack package (r=-0.164 p=0.032), that reusable cups reduce the production of wastes (r=-0,161 p=0.035), that the lack of bins is not a reason to toss wastes (r=-0,176 p=0.023) and that drying hands with paper

napkins increases the production of wastes (r=-0,176 p=0.023). Three knowledge's on how to sort wastes, broken glass cup (r=-0.218 p=0.007), broken mirror (r=-0.175 p=0.024) and apple cores (r=-0.195 p=0.014), correlates negatively with the behaviour of always or often using reusable cups at the coffee machine. On Knowledge's and Behaviours directly related, the only positive correlations were between knowing that drying hands with paper napkins increases the production of waste and never or rarely use paper towel to dry hands (r=0,183 p=0.019) and knowing that drinking bottled water increases waste production and never or rarely drinking bottled water (r=0.152 p=0.042). However, the highest correlation found was between knowing that drying hands with paper napkins increases the production of waste and never or rarely drinking bottled water (r=0,325 p=0.004). Ten significant correlations were found between Attitude and Behaviour, two of them negative. The concordance that 'despite they are light and practical, plastic packaging can be avoided' correlates positively with 'separating wastes for recycling' (r=0.173 p=0.025), 'using reusable cups at the coffee machine' (r=0.146 p=0.049), 'never toss wastes' (r=0.164 p=0.032) or 'cigarette buts' (r=0.179 p=0.021), and 'never or rarely drinking bottled water' (r=0.159 p=0.036). 'Using reusable cups' and 'never or rarely drinking bottled water' also correlates with the concordance that 'waste production is currently excessive' (r=0.178 p=0.022; and r=0.184 p=0.018, respectively). The highest positive and significant correlation between an attitude and a behaviour was found between the concordance that the 'contribution of each one of us is essential for a proper waste management and 'always and often separating wastes for recycling' (r=0.223 p=0.006). The two small negative correlations found were between 'never or rarely use paper towel to dry hands' and concordance with that 'abandoned garbage makes places unpleasant' (r=-0.194 p=0.014), and that the 'contribution of each one of us is essential for a proper waste management' (r=-0.158 p=0.037).

DISCUSSION

The University of Madeira academic community shows good levels of knowledge (81.7%) and excellent for attitudes (91.8%) on waste management, this latter being significantly higher (p=0.009). The low sample number in each subcategory only allowed a comparative analysis between two main groups, Students and Staff, but without revealing significant differences between them on those two components of the environmental literacy. However, attending specific aspects of knowledge and attitude, there are strong evidence that teachers and other staff tend to perform better than students. In fact, among the eleven (in thirty) items of knowledge in which there are significant differences between students and staff, nine were better for staff and only two for students. Also, for attitude, among the five items evaluated, three shows significant differences, all of them better for teachers and other staff. Despite we commonly assume that teachers should perform better than students, our results couldn't be explained as simple as that. Since waste management isn't a topic integrated in the curricula of the courses taught at the University of Madeira, except for 3 situations but all at the responsibility of only one teacher, and that half the sample classified as staff is not composed by teachers, the tendency to perform better on knowledge and attitudes could be explained by factors dependent on other characteristics of the group sample, namely the fact that, most probably, they must be older, more cultured and experienced, and with higher levels of education and income. In fact, previous studies shown that people with higher socioeconomic

status and levels of education, as well as older, tend do show high levels of environmental literacy (Kellert, 1985; Lyons & Breakwell, 1994; Shin et al., 2005; Tikka et al., 2000).

On the prevalence of waste management best practices (behaviour) the situation is quite different than for knowledge and attitudes. At this component of the environmental literacy, the average global result (61.6%) is significantly lower than knowledge ($p<0.001$) and attitudes ($p<0.001$), with a performance that could only be classified as moderate, and with similar results between Students (61.1%) and Staff (62%) ($p=0.403$). As so, behaviour shows a sharp drop comparing to knowledge and attitude, a situation that is common to find in other studies (Goulgouti et al., 2019; Liang et al., 2018; Spínola, 2015). This wide gap between behaviour and knowledge/attitude has been revised and explained by previous authors (McDonald, 2014; Schäufele & Janssen, 2021; Tarfaoui & Zkim, 2017) point out the barriers that needs to be surpassed in order to move from intentions to action. These barriers range from the degree of difficulty, convenience and costs to, among many others, the availability of facilitating infrastructure or solutions to perform a certain behaviour. Additionally, the knowledge/attitude-behaviour gap is also dependent on the influence of the social structure to which individuals and groups belongs and their social norms. In fact, the widely variable prevalence's of the different behaviours evaluated, ranging from almost 100% for 'never toss wastes' to only 23.5% for 'always or often using reusable cups at the coffee machine', may be a consequence, partly, of the respective degrees of difficulty associated with the different barriers for each behaviour. For example, separating wastes for recycling or never toss wastes and cigarettes buts is facilitated since there are numerous containers for selective waste collection on campus. On the contrary, avoiding the use of paper towels to dry hands in the bathrooms or the use of disposable cups in coffee vending machines, the only solutions institutionally provided, implies that each one equips oneself with reusable cups and cloth tissues as alternative solutions. This is much more difficult because it implies adopt a different solution than the one provided, and even more because there are no social support for those new behaviours.

The profile of environmental literacy for waste management found at the University of Madeira shows that the environmental education needed must centre its attention on behaviours. Since behaviours change have shown to be the most difficult goal to achieve, we propose a most effective approach based on socio-education and transformation of the physical and organizational context. For example, to reduce de prevalence of drinking bottled water, we suggest the installation of water refill stations and the distribution of reusable bottles. To increase the use of reusable cups at the coffee machines, we propose a discount on the price for those who bring their own glass, and the distribution of reusable cups. To reduce the use of paper towels to dry hands at the bathroom, we recommend the availability of other solutions, namely electric hand dryers, which has been shown to be more sustainable (Gregory et al., 2013), and the promotion of cloth handkerchiefs use. However, it is not enough to make solutions available, we need to boost a social learning process to make the behaviours of adopting it expected and desirable among the community, and to be integrated in its social norms. For that, and based on the Social Learning Theory (Jadallah et al., 2021), we recommend the adoption of an influencers approach, mobilizing groups of students, teachers and other staff to adopt those behaviours and, as live models, disseminate them among friends and colleagues.

Despite overall knowledge on waste management is good, and some excellent, there are specific ones that needs to be improved, especially on sorting for recycling certain materials. This is the case of paper coffee cups, dirty napkins, and non-packaging glass (mirror and cups), with some values much lower than 50%, requiring direct approaches for its improvement. Except for non-packaging glass, because it's not present among the wastes produced by the University of Madeira academic community, paper coffee cups, dirty napkins and Tetra Pack package are those that have been observed has the most commonly sorted at the wrong bin (data not shown). These results highlight the relevance of evaluating environmental literacy on the people environmental education is working for, as it is the only way to know to where redirect its approaches, strategies, and subjects.

The Pearson correlations help us to understand the relationship between the different items included in the characterization of the environmental literacy on waste management. The significant Pearson coefficients found were the highest among knowledge on how to sort wastes for recycling ($r>0.46$), showing medium to large positive relationships, specially between wastes with similar characteristics or degree of knowledge dissemination. Some knowledge's in how to sort wastes also correlate with other types of knowledge, namely those in knowing how to reduce waste production. Correlations between knowledge's others than those on how to sort wastes were also found, especially among the most related. As so, these findings show us that related knowledges are most prone to be learned altogether than independently, which should be taken in account when defining environmental education strategies and approaches.

Correlations between different attitudes were, despite positive, few and small, except for concordance with that 'abandoned garbage makes places unpleasant' and that 'the contribution of each one of us is essential for the proper waste management', with a medium level ($r=0.397$, $p<0.001$). Taking in consideration that Attitude levels were excellent but showing low correlations among the evaluated items, we may consider that it is an indication that each one has its own path and process to be achieved and that environmental education needs to take each one in consideration, and do not trust that only working with some the others will be reached by dragging. If Attitude shows lower levels of correlation than Knowledge, for Behaviour the results are even lowest. A relationship was only found between those that use reusable cups in coffee machines and ashtrays for cigarette butts ($r=0.287$, $p=0.001$), that is, those participants how use reusable cups and are also smokers tend to not toss cigarette buts. As interpreted for Attitude, our lack of correlations between environmental best practices could be a consequence of the existence of pathways, processes, and barriers very specific for the adoption of each behaviour. Again, environmental education should work each behaviour as a specific goal to be achieved and define the needed approaches and strategies.

When considering correlations between Knowledge, Attitude and Behaviour items, the level of correlations remains at a small level, which remembers previous studies and the lack of dependence between them (Digby, 2010; Spínola, 2020; Timur et al., 2014). The correlations found between Knowledge and Behaviour are divided evenly between negative and positive, in both situations at small level, showing the lack of dependence between both aspects. However, the fact that the positive correlations were mostly between the behaviour of sorting wastes for recycling and the knowledge in how to do it, as well as others directly related, could mean, as other authors stated (Kaiser, et al., 1999), that knowledge important to perform specific

behaviours relate each other most. The negative correlation between knowledges and behaviours also remembers us that knowing is far from being a precept for doing it. The believe that plastic packaging can be avoided represents half of the ten significative correlations found between attitudes and behaviours, which could mean that this specific item could represent a positive attitude with higher influence in changing people practices. Difficult to explain is the correlations found with the concordance that the 'contribution of each one of us is essential for a proper waste management, because it is positive with 'always and often separating wastes for recycling' ($r=0.223$ $p=0.006$) but negative with 'never or rarely use paper towel to dry hands' ($r=-0.158$ $p=0.037$).

Limitations

Although the present study contributes to the understanding of how environmental literacy is structured in a context such as that of the University of Madeira, we must take into account that it suffers from some drawbacks that may weaken its conclusions. First, the instrument designed to evaluate environmental literacy on waste management among the academic community of the University of Madeira (Portugal) doesn't show high strength on its reliability and validity indicators. Additionally, the sample number, despite sufficient, wasn't large enough to clarify the performance of more specific subgroups of the academic community and, in this way, to better understand its structure in terms of environmental literacy, namely across the different years and levels of education. To be taken in consideration is also the possibility that, among academic community, those more environmentally literate were also more prone to voluntarily answer the questionnaire, which, together with some desirability bias, could show us a picture better than the reality. In future studies, besides improving the questionnaire structure, we should choose another approach to collect samples, prioritizing the preparation of a larger and structured sample so that subgroups and demographic variables could be included. No less important will be the need to ensure the participation of members of the academic community who may be less motivated by the environmental issues, which can be obviated through individual and direct approaches that, even so, maintain anonymity.

CONCLUSION AND SUGGESTIONS

In the present context, in which we are running against time to mitigate environmental imbalances, the evaluation of the environmental literacy is of the utmost importance to redirect environmental education approaches and strategies to improve its efficacy. Present study evaluates environmental literacy on waste management on a Portuguese academic community and finds a picture in which the levels of knowledge, and even more for attitude, are very promising, despite behaviours needing substantial improvements. In a refined interpretation of the results, the study unveils the need for an environmental education approach tailored for each specific knowledge, attitude, and behaviour, and help us to select those that need to be prioritized in the near future. In this sense, in addition to very specific aspects of knowledge and attitude, the environmental education approach in the context of the University of Madeira must be redirected towards the adoption of the appropriate behaviours that could improve waste management, realizing that the success of this approach will be more dependent on changes that minimize the effect of physical and social barriers rather than strengthening levels of knowledge and attitude, as, once again, their weak relationship is confirmed.

DECLARATIONS

Data Availability: Data is available upon request to the author.

Ethical Rules: *At the time data was collected for the present study, no ethical body existed at the University of Madeira and, as so, the consent for the development of the study were tacitly given by the rectorship. Author followed ethical guidelines as outlined by the British Educational Research Association as also the General Data Protection Regulations.*

Authors Contributions: All the work was done by the author.

Conflict of Interest: There is no conflict of interests.

Acknowledge: This work was supported by FCT - Fundação para a Ciência e a Tecnologia (project UIDB/04083/2020, Portuguese Government funds).

REFERENCES

Amador, F., Martinho, A.P., Bacelar-Nicolau P., Caeiro, S., & Oliveira, C.P. (2015). Education for sustainable development in higher education: evaluating coherence between theory and praxis. *Assessment & Evaluation in Higher Education*, 40 (6), 867-882. https://doi.org/10.1080/02602938.2015.1054783.

Azeiteiro, U., Bacelar-Nicolau, P., Caetano, F., & Caeiro, S. (2015). Education for sustainable development through e-learning in higher education: Experiences from Portugal. *Journal of Cleaner Production*, *106* (1), 308-319.

Blumstein, D., & Saylan, C. (2007). The failure of environmental education (and How We Can Fix It). *PLoS Biology 5* (5), https://doi.org/10.1371/journal.pbio.0050120.

Brace, N., Kemp, R. & Snelgar, R. (2016). SPSS for Psychologists, 6th edn. Palgrave: Macmillan Education.

Caeiro, S. Hamón, L., Martins, R., & Aldaz, C. (2020). Sustainability assessment and benchmarking in higher education ınstitutions- a critical reflection. *Sustainability*, 12(2), 543.

Chen, D.M-C., Bodirsky, B.L., Krueger, T., Mishra, A., & Popp, A. (2020). The world's growing municipal solid waste: trends and impacts. *Environment Research Letters*; 15(7). http://doi.org/10.1088/1748-9326/ab8659

Cook, S., & Berrenberg, J. L. (1981). Approaches to encouraging conservation behavior: a review and conceptual framework. *Journal of Social Issues*, 37 (2): 73-107.

Dalberg Advisors. (2019). No Plastic in Nature: Assessing plastic ingestion from nature to people. WWF. Gland, Switzerland. Accessed 15th March 2020 at https://d2ouvy59p0dg6k.cloudfront.net/downloads/plastic_ingestion_web_spreads.pdf.

Department of Economic and Social Affairs (n.d.)a. Goals 12 Ensure sustainable consumption and production patterns. United Nations. Retrieved 30 March 2022 from https://sdgs.un.org/goals/goal12

Department of Economic and Social Affairs (n.d.)b. Goals 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development. United Nations. Retrieved 30 March 2022 from https://sdgs.un.org/goals/goal14

Digby, C.L.B. (2010). An Examination of the Impact of Non-formal and Informal Learning on Adult Environmental Knowledge, Attitudes, and Behaviors. A dissertation submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of doctor in Philosophy. University of Minnesota.

Disinger, J. F., & Roth, C.E. (1992). Environmental Education research news. *The Environmentalist*, 12, 165-168.

Farinha C., Azeiteiro U., & Caeiro S. (2017) Education for Sustainable Development Through Policies and Strategies in the Public Portuguese Higher Education Institutions. In: Leal Filho W., Azeiteiro U., Alves F., Molthan-Hill P. (eds) Handbook of Theory and Practice of Sustainable Development in Higher Education. World Sustainability Series. Springer, Cham.

Farinha, C., Azeiteiro, U., & Caeiro, S. (2018). Education for sustainable development in Portuguese universities: The key actors' opinions. *International Journal of Sustainability in Higher Education*, 19 (5), 912-941. https://doi.org/10.1108/IJSHE-09-2017-0168

Farinha, C., Sandra Caeiro, S., & Azeiteiro, U. (2019). Sustainability Strategies in Portuguese Higher Education Institutions: Commitments and Practices from Internal Insights. *Sustainability*, 11(11), 1-25.

Filho, W., Wu, Y.J., Brandli, L., Avila, L., Azeiteiro, U., Caeiro, S., & Madruga, L. (2017). Identifying and overcoming obstacles to the implementation of sustainable development at universities. *Journal of Integrative Environmental Sciences*, *14* (1), 93-108. http://doi.org/10.1080/1943815X.2017.1362007.

Fonseca, L.M., Portela, A.R., Duarte, B., Queirós, J., & Paiva, L. (2018). Mapping higher education for sustainable development in Portugal. *Management & Marketing*, 13 (3), 1064-1075. https://doi.org/10.2478/mmcks-2018-0023

Graham J. (2006). Congeneric and (Essentially) Tau-Equivalent estimates of score reliability: what they are and how to use them. *Educational Psychological Measurement*, 66: 930-944. http://doi.org/10.1177/0013164406288165.

Goulgouti, A., Plakitsi, K., & Stylos, G. (2019). Environmental literacy: evaluating knowledge, affect, and behavior of pre-service teachers in Greece. *Interdisciplinary Journal of Environmental and Science Education*, 15(1), Article e02202. https://doi.org/10.29333/ijese/6287

Gregory, J.R., Montalbo, T.M., & Kirchain, R.E. (2013). Analysing uncertainty in a comparative life cycle assessment of hand drying systems. *Int J Life Cycle Assess,* 18, 1605–1617.

Hallfreðsdóttir, S. (2011). Eco Schools – Are They Really Better? Comparison of Environmental Knowledge, Attitude and Actions between Students in Environmentally Certified Schools and Traditional Schools in Iceland A thesis submitted in partial fulfilment of the requirements of Lund University International Master's. Programme in Environmental Studies and Sustainability Science (LUMES). Lund University Centre for Sustainability Studies, LUND, Sweden.

Krnel D., & Naglič, S. (2009). Environmental literacy comparison between eco-schools and ordinary schools in Slovenia. *Science Education International*, 20(1/2), 5-24.

Hollweg, K.S., Taylor, J.R., Bybee, R.W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). Developing a framework for assessing environmental literacy. Washington, DC: North American Association for Environmental Education.

Hungerford, H.R., & Volk, T. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21 (3), 8-22.

Igbokwe, A.B. (2012). Environmental Literacy Assessment: Exploring the Potential for the Assessment of Environmental Education/Programs in Ontario Schools. *International Journal for Cross-Disciplinary Subjects in Education* (IJCDSE), 3 (1), 640-656.

Jadallah, C.C., & Ballard, H.L. (2021). Social learning in conservation and natural resource management: taking a sociocultural perspective. *Ecology and Society*, 26(4),37. https://doi.org/10.5751/ES-12654-260437

Kaiser, F., Wolfing, S., & Fuhrer, U. (1999). Environmental attitude and ecological behavior. *Journal of Environmental Psychology*, 19, 1-19.

Kellert, S.R. (1985). Attitudes toward animals; age-related development among children. The Journal of Environmental Education, 16(3), 29-39.

Kissinger, M., Sussman, C., Moore, J., & Rees, W.E. (2013). Accounting for the Ecological Footprint of Materials in Consumer Goods at the Urban Scale. *Sustainability* 5, 1960-1973. http://doi.org/10.3390/su5051960.

Kuhlemeier, H., Bergh, H., & Lagerweij, N. (1999). Environmental Knowledge, Attitudes, and Behavior in Dutch Secondary Education. *The Journal of Environmental Education*, *30* (2), 4-14.

Leite, L., & Dourado, L. (2015). Educação ambiental e para o desenvolvimento sustentável na formação de graduados em educação. *Revista Comunicações, Piracicaba (SP)*, 22 (1), 285-307.

Leslie, H.A., van Velzen M.J.M., Brandsma, S.H., Vethaak, D., Garcia-Vallejo, J.J., & Lamoree, M.H. (2022). Discovery and quantification of plastic particle pollution in human blood. *Environment International*, 163, Article 107199. https://doi.org/10.1016/j.envint.2022.107199

Liang, A-W., Fang W-T., Yeh S-C., Liu S-Y., Tsai H-M., Chou, J-Y., & Eric Ng, E. (2018). A nationwide survey evaluating the environmental literacy of undergraduate students in Taiwan. *Sustainability*. http://doi.org/10.3390/su10061730.

Lumsden, S. (2018). Ecological crisis and the problem of how to ınhabit a norm. *Ethics and the environment, 23*(1), 29-48. http://doi.org/10.2979/ethicsenviro.23.1.03.

Lyons, E., & Breakwell, G.M. (1994). Factor predicting environmental concern and indifference in 13- to 16-years-old. *Environment and Behavior*, 26(2), 223-238.

McBeth, W. & Volk, T.L. (2010). The national environmental literacy project: A baseline study of middle grade students in United States. *The Journal of Environmental Education*, 41(1), 55-67.

McDonald, F. (2014) Developing an Integrated Conceptual Framework of Pro-Environmental Behavior in the Workplace through Synthesis of the Current Literature. *Administrative Sciences*, 4 (3), 276-303.

Nunnally J, Bernstein L. (1994). *Psychometric theory*. New York: McGraw-Hill Higher, INC.

Otto, D., Caeiro, S., Nicolau, P., Disterheft, A., Teixeira, A., Becker, S., Bollmann, A., & Sander, K. (2019). Can MOOCs empower people to critically think about climate change? A learning outcome based comparison of two MOOCs. *Journal of Cleaner Production*, 222(10), 12-21.

Pabortsava, K., & Lampitt, R.S. (2020). High concentrations of plastic hidden beneath the surface of the Atlantic Ocean. *Nature Communications,* 11.

Pallant, J. (2007). *SPSS survival manual: A step by step guide to data analysis SPSS for windows third edition*. Open University Press. New York, NY.

Pe'er, S., Goldman, D., & Yavetz, B. (2007). Environmental literacy in teacher training: attitudes, knowledge, and environmental behavior of beginning students. *The Journal of Environmental Education*, 39(1), 45-59.

Schäufele, I., & Janssen, M. (2021). How and Why Does the Attitude-Behavior Gap Differ Between Product Categories of Sustainable Food? Analysis of Organic Food Purchases Based on Household Panel Data. *Frontiers in Psychology*, 12:595636. http://doi.org/10.3389/fpsyg.2021.595636.

Schmidt, L., Guerra, J., & Nave, J. G. (2010). The role of non-scholar organizations in environmental education: A case study from Portugal. International Journal of *Environment and Sustainable Development*, 9 (1/2/3), 16–29.

Schmidt, L., Nave, J.G., O'Riordan, T., & Guerra, J. (2011). Trends and dilemmas facing environmental education in Portugal: From environmental problem assessment to citizenship ınvolvement. *Journal of Environmental Policy & Planning*, 13(2), 159–177.

Shin, D., Chu, H., Lee, E., Ko, H., Lee, M., Kang, K., Min, B., & Park, J. (2005). An assessment of Korean students' environmental literacy. *Journal of Korean Earth Science Society*, 26(4), 358-364.

Spínola, H. (2012). Sustainable Development Contributions among University of Madeira (Portugal) Students. *World Academy of Science Engineering and Technology*, 66, 890- 895.

Spínola, H. (2014). Forty years of environmental education in the Portuguese Democracy. *The Online Journal of New Horizons in Education*, 4 (3), 47-55. http://hdl.handle.net/10400.13/1363

Spínola, H. (2015). Environmental literacy comparison between students taught in Eco-schools and ordinary schools in Madeira Island region of Portugal. *Science Education International*, 26 (3), 392-413.

Spínola, H. (2016). Environmental literacy in Madeira Island (Portugal): The ınfluence of demographic variables. *International Electronic Journal of Environmental Education*, 6(2), 92-107. http://hdl.handle.net/10400.13/1358.

Spínola, H. (2020). Correlations between environmental literacy components (knowledge, attitude and behavior) in Madeira Island (Portugal) 9th grade students. *The Online Journal of New Horizons in Education*, 10 (1), 28-36.

Stern, P. (2000). Toward a coherent theory of environmentally significant behavior. *The Journal of Social Issues*, 56 (3), 407.

Tarfaoui, D., & Zkim, S. (2017). Ecological attitude- behavior gap: a theoretical analysis. *International Journal of Economics & Strategic Management of Business Process (ESMB)*, 8(1), 33-38.

Tikka, P.M., Kuitunen, M.T., & Tynys, S.M. (2000). Effects of educational background on students' attitudes, activity levels and knowledge concerning the environment. *The Journal of Environmental Education*, 31(3), 12-19.

Timur, S., Timur, B., & Karakas A. (2014). Investigating Pre-service Teachers' Knowledge and Behaviors toward Environment. *Anthropologist*, 17(1), 25-35.

Tracana, R.B., Ferreira, E., & Carvalho, G. (2012). Environmental Education in Portuguese School Programmes andmTextbooks in Two Periods: 1991-2000 and 2001-2006. *The Online Journal Of New Horizons In Education*, 2(1), 57-67.

Wilson, D.C., & Velis, C.A. (2015). Waste management-still a global challenge in the 21st century: an evidence-based call for action *Waste Manage. Res*. 33, 1049–1051.

Appendix 1- Questionnaire

Environmental literacy on waste management

This survey is anonymous and aims to assess the level of environmental literacy of the academic community of the University of Madeira regarding waste management. It covers knowledge (section 1), attitudes (section 2) and behaviour (section 3) and the entire survey takes less than 10 minutes to complete.

I am…

Student of a technical course

Undergraduate student (1st year)

Undergraduate student (2nd year)

Undergraduate student (3rd year)

Master student

Doctoral student

Teacher

Staff (non-teacher)

Section I- Knowledge

I.1- Which of the following materials, as a residue, is the worst for the environment?

Paper; Plastic; Orange peel; Can; Glass; Ceramics.

I.2- For a better waste management, what do you consider to be more important?

Reuse; Incinerate; Recycle; Abandon; Reduce; Bury.

I.3- Separate the following list of waste for each of the indicated containers (Paper-blue; Glass- green; Plastic/metal packaging- yellow; General garbage bin; I don't know):

Yogurt plastic cup; French fries' package; Glass jar; Dirty napkins; Apple core; Aluminium foil; Paper sheet; Broken mirror; Banana peel; Glass bottle; Plastic bottle; Metal cap; Broken glass cup; Broken teacup; Tetra Pack package; Plastic bag; Paper coffee cups; Soda can; Journal or magazine.

I.4- Select all the statements with which you agree:

Drinking bottled water increases waste production.

Garbage on the floor results from the lack of dustbins.

Reusable cups reduce the production of waste.

Plastic bottles are better for the environment than glass ones.

Garbage, if recycled, does not cause pollution.

Drying hands with paper napkins increases the production of waste.

Bringing lunch from home increases the production of waste.

Cigarette butts are biodegradable.

Tap water is of questionable quality.

Section II- Attitude

Please indicate your level of agreement with each of the following statements:

II.1- Waste production is currently excessive.

1-Totally disagree; 2-Disagree; 3- Don't agree nor disagree; 4- Agree; 5-Totally agree.

II.2- The pollution due to waste production is a minor issue.

1-Totally disagree; 2-Disagree; 3- Don't agree nor disagree; 4- Agree; 5-Totally agree.

II.3- Abandoned garbage makes places unpleasant.

1-Totally disagree; 2-Disagree; 3- Don't agree nor disagree; 4- Agree; 5-Totally agree.

II.4- Because they are light and practical, plastic packaging cannot be avoided.

1-Totally disagree; 2-Disagree; 3- Don't agree nor disagree; 4- Agree; 5-Totally agree.

II.5- The contribution of each one of us is essential for the proper waste management.

1-Totally disagree; 2-Disagree; 3- Don't agree nor disagree; 4- Agree; 5-Totally agree.

Section III- Behaviour

Define how often you develop the following behaviours at the University of Madeira:

III.1- I sort my wastes for recycling.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always

III.2- In the bathroom, I dry my hands with paper towels.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always

III.3- I use reusable cups in coffee machines.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always; 6- I don't use coffee machines.

III.4- I leave garbage out of the trash cans.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always

III.5- I drink bottled water.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always

III.6- I toss cigarette butts on the floor.

1- Never; 2- Rarely; 3- Sometimes; 4- Often; 5- Always; 6- I'm not a smoker.