

## CORRELATION BETWEEN ENVIRONMENTAL LITERACY COMPONENTS (KNOWLEDGE, ATTITUDE AND BEHAVIOR) IN MADEIRA ISLAND (PORTUGAL) 9<sup>TH</sup> GRADE STUDENTS

Hélder Spínola

Center for Research in Education, University of Madeira, Campus Universitário da Penteada  
9000-390 Funchal

Portugal

[hspinola@uma.pt](mailto:hspinola@uma.pt) - [hspinola@staff.uma.pt](mailto:hspinola@staff.uma.pt)

### ABSTRACT:

Pearson's correlations among environmental literacy main components for 9<sup>th</sup> grade students from Madeira Island (Portugal) reveal the known intricacy of the framework for environmentally responsible behaviors. Findings show that knowledge, attitude and behavior correlate each other positively and significantly in a small level, and that demographic variables strongly influence these relationships. The established relationship among the environmental literacy main components shows a pathway where knowledge has greater ease on changing attitudes ( $r=0.276$ ,  $p=0.000$ ) than behaviors ( $r=0.198$ ,  $p=0.000$ ), being behaviors more related to attitudes ( $p=0.224$ ,  $p=0.000$ ). Also, since the shared variance between components was very small, other factors not evaluated on present study should play a major role among 9<sup>th</sup> grade students from Madeira Island.

**Keywords:** Environmental Literacy components, environmental knowledge, New Ecologic Paradigm, environmentally responsible behavior, correlations.

### 1. INTRODUCTION

The main goal of environmental education is to improve environmental literacy, a very difficult task considering that a profusion of different factors acts in an interdependent and complex way to achieve it (Hollweg et. al., 2011). Despite several models and frameworks have been proposed to explain the pathway through which environmental literacy and, particularly, environmentally responsible behaviors develop, its complex structure and interdependencies still not completely known and understood (Hsu, 1997; Keene & Blumstein, 2010).

In the early 1990s, environmental literacy was considered essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems (Disinger and Roth, 1992). After that, Simmons (1995, pp. 55-58) identified seven elements of environmental literacy: 1. Affect (e.g., environmental sensitivity, attitudes, and moral reasoning); 2. Ecological knowledge; 3. Socio-political knowledge (e.g., the relationship of cultural, political, economic, and other social factors to ecology and environment); 4. Knowledge on environmental issues; 5. Skills pertaining to environmental problems/issues and action strategies, systemic thinking, and forecasting; 6. Determinants of environmentally responsible behavior (i.e., locus of control and assumption of personal responsibility); 7. Behavior (i.e., various forms of active participation aimed at solving problems and resolving issues). Another framework example, created by Wilke (1995, pp. 5-6), defined four clusters of environmental literacy components: cognitive dimensions (knowledge and skill), affective dimensions, additional determinants of environmentally responsible behavior, and personal and/or group involvement in environmentally responsible behavior.

Nowadays, is of common understanding that environmental literacy must include knowledge and understanding of environmental concepts, problems, and issues, a set of cognitive and affective dispositions, and a set of cognitive skills and abilities, together with the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts (Hollweg et al., 2011). As a simple definition, environmental literacy could be seen as a domain of four interrelated components: knowledge, dispositions, competencies, and environmentally responsible behavior (Hungerford & Volk, 1990; Hollweg et al., 2011). However, since it is not possible to include its whole structure in any single assessment, several authors identified knowledge, attitude and environmentally responsible behavior as the most important environmental literacy components to be included in surveys (Krnel & Naglič, 2009; McBeth & Volk, 2010; Kuhlemeier, et. al., 1999).

Along past decades several theories and models have been developed in order to explain the way knowledge, attitude and behavior environmental literacy components relate to each other and, particularly, mediate behavior (Kibert, 2000). One of the most widespread of these models is Azjen's (1988) Theory of Planned Behavior, an evolution of the Theory of Reasoned Action (Azjen & Fishbein, 1980), where attitudes and subjective norms (individual's perception about the beliefs of their nearest society's members) contribute to behavioral intentions, which then conduct to behaviors adoption. In fact, social environment has been shown to mediate the influence

of environmental attitudes on environmental behaviors (Petzelka & Korsching, 1996) and, despite not directly specified in this model, knowledge elements are represented through their influence on beliefs, assuming a mediated connection through attitudes, subjective norms and intention prior to behavior (Dillon & Gayford, 1997). The Theory of Planned Behavior also adds that, besides attitude and subjective norms, a perceived behavioral control component influence, directly or through intentions, the behavior adoption (Kibert, 2000). This perceived behavioral control component “refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles (Ajzen 1988, p. 132), acting as a mediating factor of whether or not an individual, independently from their attitude, will engage in environmentally responsible behaviors (Kibert, 2000). Another important model is the one of the Responsible Environmental Behavior proposed by Hines and colleagues (1986/87). Unlike the Theory of Planned Behavior, this model describes how different types of knowledge interact to determine the intention to act, which then leads to the desired environmentally responsible behavior. This knowledge should not be only factual but also on action strategies and issues in order to allow individuals to adapt when situational factors create changeable conditions. Nevertheless, the model of Responsible Environmental Behavior emphasizes that, besides the different types of knowledge and action skills, self-efficacy (locus of control) and environmentally sensitive attitudes are essential components to drive behaviors that needs to be developed through environmental education (Kibert, 2000).

Those, under the above and other frameworks, and confirming its complexity and multifactorial dependence, environmental literacy has been commonly investigated in different populations, and several variables, such as age, gender, income, place of residence and parental education level, among others, have been found to be its predictors (Erdoğan, 2009). Also, knowledge, attitude and behavior towards the environment, the main components of environmental literacy, have been correlated in order to evaluate and better understand the way they interact in different populations. Environmental knowledge has been found to be highly correlated with environmentally responsible behavior in some studies (Sia et al., 1985/86:  $r = 0.55$ ) (Hsu & Roth, 1998:  $r = 0.46$ ) but weakly in others (Kuhlemeier et al., 1999:  $r = 0.20$ ) (Timur et al., 2014:  $r=0.111$ ). It seems that these inconsistent results are dependent on the kind of knowledge considered, showing higher correlations when knowledge about an ecological behavior rather than factual knowledge is considered (Kaiser et al., 1999). Also, other factors seem to influence the correlation since different values have been obtained depending on the characteristics of the population (Hines et al., 1986/87: individuals from environmental organizations  $r=0.691$ , general public  $r=0.268$ , and children  $r=0.192$ ; Kibert, 2000: undergraduate university students  $r=$  not significant; Kuhlemeier et al., 1999: 9<sup>th</sup> grade students in Holland  $r=0.20$ ; Ngev et al., 2008: 6<sup>th</sup> and 12<sup>th</sup> grade students in Israel,  $r=$  not significant; Timur et al., 2014: pre-service teachers  $r=0.111$ ; Digby, 2010: Adults from Minnesota, USA:  $r=0.178$ ). Knowledge also correlates with attitude, again varying depending on the population and its characteristics (Digby, 2010: Adults from Minnesota, USA:  $r=0.145$ ; Ngev et al., 2008: 6<sup>th</sup> grade,  $r=0.4101$ , and 12<sup>th</sup> grade students,  $r=0.23$ , in Israel) but, despite some variation, the components that tends to show highest correlations are attitude and behavior (Makki et al., 2003: Lebanon secondary students’  $r= 0.77$ ; Meinhold & Malkus, 2005: adults in USA West Coast  $r=0.45$ ; Kuhlemeier et al., 1999: 9<sup>th</sup> grade students in Holland  $r=0.36$ ; Ngev et al., 2008: 6<sup>th</sup> grade,  $r=0.3695$ , and 12<sup>th</sup> grade students,  $r=0.56$ , in Israel; Digby, 2010: Adults from Minnesota, USA:  $r=0.267$ ).

Despite environmental literacy has been investigated all over the world since the past three decades, this concept has been disregarded in Portuguese environmental education and research. However, some studies have been developed with particular focus on knowledge and attitude toward the environment, being the environmentally responsible behavior almost forgotten (Spinola, 2015; Spinola, 2014; Câmara, 2014; Almeida & Azeiteiro, 2011; Cordeiro, 2010; Pedro, 2009; Freitas, 2007). Some of them, despite several statistic limitations, consider also the influence of categorical and demographic variables as predictors for environmental literacy but none evaluates the correlations between the main components of environmental literacy: knowledge, attitude and behavior. Madeira is an insular region of Portugal where environmental literacy studies are even scarcer. However, since Madeira population is socio-culturally similar to the rest of the country, as well because the school curriculum and education system is the same, studying its environmental literacy could contribute to enlighten the subject in Portugal and overseas.

## 2. RESEARCH QUESTIONS

The purpose of present study is to determine, for the first time, whether there is, or not, a correlation between the environmental literacy components of knowledge, attitude, and behavior in 9<sup>th</sup> grade students from Madeira Island (Portugal). So, we put the following questions: Knowledge and attitude towards the environment correlate each other positively and significantly, and with environmentally responsible behavior in 9<sup>th</sup> grade students from Madeira Island (Portugal)? And, if yes, to which extend does they correlate? Does any specific items on knowledge, attitude and behavior correlates higher than the overall components of environmental

literacy? Do demographic variables influence the levels of correlation between knowledge, attitude and behavior?

Therefore, and taking in consideration previous studies, we hypothesized that:

- 1- Knowledge, attitude and behaviors toward the environment in 9<sup>th</sup> grade students from Madeira Island correlate each other but attitude and behavior correlate higher than knowledge and behavior, and even knowledge and attitude;
- 2- Environmental literacy components in Madeira Island 9<sup>th</sup> grade students correlate significantly and positively in a medium level;
- 3- Specific knowledge in who to correctly perform environmentally responsible actions correlates higher with the adoption of the respective specific behaviors than overall.
- 4- Demographic variables influence the levels of correlation between knowledge, attitude and behavior.

### 3. METHOD

The survey design was based in others published elsewhere but adjusted to local specificities (Kuhlemeier et al., 1999; Krnel & Naglič, 2009; McBeth & Volk, 2010). It was anonymous with close-ended questions, consisting of a header and three main sections, each one measuring and assessing: knowledge (10 questions), attitude (15 questions) and environmentally responsible behavior (15 questions) (questionnaire available upon request). Knowledge section addressed the 3 main themes developed in environmental education activities on Portuguese schools: water (3 questions), energy (3 questions), and wastes (4 questions); each one going along 3 main aspects: cause of problems, regional context and behavior options. To measure pro-environmental attitude the questionnaire included the New Ecologic Paradigm (NEP) Scale, an instrument widely validated in the measure of pro-environmental orientation (Dunlap et al., 2000; Trobe & Acott, 2000; Kostova et al., 2011; Shoukry et al., 2012). The environmentally responsible behaviors were assessed through statements spanning across the 3 main themes already selected for knowledge: water (4 statements), energy (6 statements) and wastes (5 statements). Each statement addressed specific everyday behaviors and students were asked to select their frequency in a Likert-type scale ranging from 1 (never) to 5 (always). A special care was taken to overcome potential social desirability bias that could overcome in self-reported assessments (Nederhof, 1985). In order to obtain an internal validity indicator, two redundant questions [“a) I put paper, glass bottles and plastic bags in different containers” and j) “I put all kind of wastes in the same container”] were added. The questionnaire was pre-tested, and the final version was applied to all sample students between April and May 2013, after informed consent from each school board.

The sample included 491 9<sup>th</sup> grade students from 5 elementary schools from Madeira Island (Portugal). Data collected in the survey was entered into a Microsoft Office Excel worksheet coding in 1 to 5 the responses based on the Likert-type scale employed for the attitude and behavioral sections, and for correct answers in the knowledge section. Following coding, the data was imported into IBM SPSS statistics software (version 23) for statistical analysis. Firstly, reliability (the Cronbach’s Alpha score was 0.705 for the entire measuring instrument) and validity (confirmed by factor analysis and internal validity indicator questions that show a significant large positive correlation [ $r=0.641$   $p=0.000$ ]) were evaluated followed by a set of descriptive statistics. Composite scores for each section and, in each section, for specific group items were calculated and then Pearson’s correlations ( $r$ ) and the shared variance ( $r^2 \times 100$ ) were determined. 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).

### 4. RESULTS

The 491 9<sup>th</sup> grade students involved in this survey had a mean age of 15 years, males (51.3%) are slightly most prevalent than females (48.7%) and 45% are from educational establishments involved in the environmental education Eco-Schools Program. More than two thirds (65%) reside in an urban area (Funchal city) and the remaining (35%) in rural municipalities. Students with higher marks in 8<sup>th</sup> grade Natural Sciences discipline (4 or more, in a scale of five points) were most prevalent (52.1%) that the others (47.9%, with 3 or less) and only 20.6% admit to had been involved in environmental activities at school along the past few years. Missing values account for 3.1% on total sample.

Ninth grade students from Madeira Island showed an average correct answers of 71.8% on knowledge section, an average value of 3.59 on New Ecological Paradigm (NEP) scale for attitude (meaning that, in average, they rank between undefined and pro-NEP) and an average value of 3.43 for environmentally responsible behaviors (meaning that, in average, they practice environmentally responsible behaviors in a prevalence between ‘sometimes’ and ‘very often’). The values obtained for group items in each section reflect the overall results but show some variations in knowledge (water: 65.9%; energy: 71.3%; and wastes: 72.5%), attitude (limits to growth: 3.00- undefined; anti-anthropocentrism: 4.00- pro NEP; fragility of nature’s balance: 3.67- between

undefined and pro NEP; rejection of exemptionalism: 3.44- between undefined and pro NEP; and possibility of an eco-crisis: 3.70- between undefined and pro NEP) and behaviors (water savings: 3.67- between 'sometimes' and 'very often'; energy savings: 3.22- between 'sometimes' and 'very often'; and wastes management: 3.55- between 'sometimes' and 'very often').

Pearson's correlations among environmental literacy main components show small positive but significant relationships in 9<sup>th</sup> grade students from Madeira Island (table 1). The highest correlation values were found for knowledge and attitude (total sample  $r=0.277$ ,  $p=0.000$ ), reaching a medium positive relationship in rural ( $r=0.340$ ,  $p=0.000$ ), male ( $r=0.301$ ,  $p=0.000$ ) and among students that assume to have not participated in environmental activities at school ( $r=0.324$ ,  $p=0.000$ ). Among these two components, the group items with the highest Pearson's correlation value were 'waste knowledge' and the pro-NEP attitude concordance with 'fragility of nature's balance' ( $r=0.281$ ,  $p=0.00$ ) (table 2), particularly higher for rural ( $r=0.401$ ,  $p=0.000$ ) and male students ( $r=0.376$ ,  $p=0.000$ ). For rural students 'waste knowledge' also correlates higher than overall students for pro-NEP attitude concordance with the 'possibility of an eco-crisis' ( $r=0.367$ ,  $p=0.000$ ). On the other hand, none of the thematic knowledges considered (water, energy and wastes) correlates with the pro-NEP attitude concordance with the existence of 'limits to growth' (table 2).

As expected, considering previous studies, the lowest values of correlation were found between knowledge and behavior ( $r=0.198$ ,  $p=0.00$ ), a value similar to Dutch 9<sup>th</sup> grade students (Kuhlemeier et al., 1999), being lower for rural and students with a worst performance in the 8<sup>th</sup> grade Natural Sciences discipline (table 1). Furthermore, in opposition to previous studies (Kaiser et al., 1999) and rejecting our hypothesis, thematic knowledge on water, energy and wastes doesn't correlate any better with the adoption of behaviors in each one of those areas (table 2). Surprisingly, the highest group items correlation was between 'waste knowledge' and 'water saving behaviors' ( $r=0.196$ ,  $p=0.00$ ) when with 'waste management behaviors' the value was no higher than  $r=0.129$  (table 2). Moreover, even most specific knowledge's undoubtedly important for behavior performance doesn't correlate higher with the respective behaviors. For example, knowledge on waste segregation for recycling and the respective behavior correlates only with  $r=0.131$  ( $p=0.005$ ) and even knowing that switching off television directly on the apparatus button eliminates stand by consumption and saves energy correlates weakly with that specific behavior ( $r=0.157$ ,  $p=0.024$ ).

Despite with high values in other studies (Makki et al., 2003; Meinhold & Malkus, 2005; Kuhlemeier et al., 1999; Ngev et al., 2008), attitude and behavior among 9<sup>th</sup> grade students from Madeira island also showed a small positive correlation with  $r=0.224$  ( $p=0.000$ ), rising for male ( $r=0.287$ ,  $p=0.000$ ) and particularly for students with a better performance in the 8<sup>th</sup> grade Natural Sciences discipline (table 1). Among these two environmental literacy components, significant and positive values of correlation, despite at small level, were found between behaviors of both waste management and water savings, with almost all NEP group items (table 2). However, for energy saving behaviors only pro-NEP 'anti-anthropocentrism' orientation had show a positive and significant correlation ( $r=0.124$ ,  $p=0.007$ ).

Internal correlation among each environmental literacy component tends to be higher than the above presented results (table 2). The highest internal correlations were found among NEP attitude, especially for pro NEP concordance with 'fragility of nature's balance' and 'possibility of an eco-crisis' ( $r=0.885$ ,  $p=0.00$ ), followed by 'anti-anthropocentrism' and 'rejection of exemptionalism' for human species ( $r=0.494$ ,  $p=0.00$ ). Internal correlations among knowledge group items were low with no significant relationship at all between water and wastes ( $r=0.059$ ,  $p=0.19$ ). For behaviors, the internal correlation values were found to be higher than in knowledge but lower than in attitude, reaching  $r=0.304$  ( $p=0.00$ ) for waste management and water saving behaviors (table 2).

Table 1. Pearson's correlations (r), percentage of shared variance ( $r^2 \times 100$ ) and significance (p) between knowledge, attitude and behavior environmental literacy components in 9<sup>th</sup> grade students from Madeira Island, by total, female, male, urban, rural, marks lower or equal to 3 ( $\leq 3NS$ ) and higher or equal to 4 in 8<sup>th</sup> grade Natural Sciences discipline ( $\geq 4NS$ ), eco-schools (ES), non eco-schools (NES), participants in environmental activities (EA) and nonparticipants in environmental activities (NEA). n= number of samples.

	Total	Female	Male	Urban	Rural	$\leq 3NS$	$\geq 4NS$	ES	NES	EA	NEA
Knowledge Behavior	r=0.198 $r^2=3.9$ % n=486 p=0.000	r=0.190 $r^2=3.6$ % n=237 p=0.003	r=0.179 $r^2=3.2$ % n=244 p=0.005	r=0.221 $r^2=4.9$ % n=346 p=0.000	r=0.144 $r^2=2.1$ % n=140 p=0.09	r=0.134 $r^2=1.8$ % n=229 p=0.043	r=0.279 $r^2=7.8$ % n=241 p=0.000	r=0.175 $r^2=3.1$ % n=219 p=0.009	r=0.217 $r^2=4.7$ % n=267 p=0.000	r=0.207 $r^2=4.3$ % n=99 p=0.04	r=0.195 $r^2=3.8$ % n=381 p=0.000
Knowledge Attitude	r=0.276 $r^2=7.6$ % n=480 p=0.000	r=0.249 $r^2=6.2$ % n=235 p=0.000	r=0.301 $r^2=9.1$ % n=240 p=0.000	r=0.252 $r^2=6.4$ % n=345 p=0.000	r=0.340 $r^2=11.6$ % n=135 p=0.000	r=0.257 $r^2=6.6$ % n=226 p=0.000	r=0.223 $r^2=5.0$ % n=238 p=0.001	r=0.271 $r^2=7.3$ % n=212 p=0.000	r=0.282 $r^2=8.0$ % n=268 p=0.000	r=0.082 $r^2=0.7$ % n=95 p=0.43	r=0.324 $r^2=10.5$ % n=379 p=0.000
Attitude Behavior	r=0.224 $r^2=5.0$ % n=474 p=0.000	r=0.174 $r^2=3.0$ % n=233 p=0.008	r=0.287 $r^2=8.2$ % n=236 p=0.000	r=0.221 $r^2=4.9$ % n=340 p=0.000	r=0.248 $r^2=6.2$ % n=134 p=0.004	r=0.145 $r^2=2.1$ % n=226 p=0.03	r=0.312 $r^2=9.7$ % n=232 p=0.000	r=0.196 $r^2=3.8$ % n=211 p=0.004	r=0.248 $r^2=6.2$ % n=263 p=0.000	r=0.248 $r^2=6.2$ % n=95 p=0.015	r=0.215 $r^2=4.6$ % n=381 p=0.000

Table 2. Pearson's correlations (r) between group items on knowledge, attitude and behavior environmental literacy components for 9<sup>th</sup> grade students from Madeira Island. Significant results in bold.

Correlated variables	1	2	3	4	5	6	7	8	9	10	11
1-Water knowledge		<b>r=0.158</b> <b>p=0.000</b>	r=0.059 p=0.19	r=0.043 p=0.35	r=-0.012 p=0.80	<b>r=0.099</b> <b>p=0.03</b>	r=0.052 p=0.26	<b>r=0.098</b> <b>p=0.03</b>	r=0.027 p=0.55	<b>r=0.184</b> <b>p=0.00</b>	r=0.010 p=0.82
2-Energy knowledge			<b>r=0.232</b> <b>p=0.00</b>	r=0.023 p=0.62	<b>r=0.094</b> <b>p=0.039</b>	r=0.088 p=0.055	<b>r=0.132</b> <b>p=0.004</b>	<b>r=0.133</b> <b>p=0.00</b>	r=0.087 p=0.055	r=0.055 p=0.23	r=0.048 p=0.29
3- Wastes knowledge				r=0.041 p=0.37	<b>r=0.205</b> <b>p=0.00</b>	<b>r=0.281</b> <b>p=0.00</b>	<b>r=0.176</b> <b>p=0.00</b>	<b>r=0.251</b> <b>p=0.00</b>	<b>r=0.196</b> <b>p=0.00</b>	r=0.047 p=0.30	<b>r=0.129</b> <b>p=0.00</b>
4- NEP limits to growth					<b>r=0.161</b> <b>p=0.00</b>	<b>r=0.176</b> <b>p=0.00</b>	<b>r=0.218</b> <b>p=0.00</b>	<b>r=0.204</b> <b>p=0.00</b>	r=0.021 p=0.65	r=0.038 p=0.41	r=0.061 p=0.19
5- NEP anti-anthropocentrism						<b>r=0.410</b> <b>p=0.00</b>	<b>r=0.494</b> <b>p=0.00</b>	<b>r=0.395</b> <b>p=0.00</b>	<b>r=0.175</b> <b>p=0.00</b>	<b>r=0.124</b> <b>p=0.007</b>	<b>r=0.162</b> <b>p=0.00</b>
6- NEP fragility of nature's balance							<b>r=0.360</b> <b>p=0.00</b>	<b>r=0.885</b> <b>p=0.00</b>	<b>r=0.146</b> <b>p=0.001</b>	r=0.066 p=0.15	<b>r=0.143</b> <b>p=0.00</b>
7- NEP rejection of exemptionalism								<b>r=0.383</b> <b>p=0.00</b>	<b>r=0.165</b> <b>p=0.00</b>	r=0.079 p=0.088	<b>r=0.120</b> <b>p=0.01</b>
8- NEP possibility of an eco-crisis									<b>r=0.162</b> <b>p=0.00</b>	r=0.051 p=0.265	<b>r=0.154</b> <b>p=0.00</b>
9- Water saving behaviors										<b>r=0.240</b> <b>p=0.00</b>	<b>r=0.304</b> <b>p=0.00</b>
10- Energy saving behaviors											<b>r=0.211</b> <b>p=0.00</b>
11- Wastes management behaviors											

#### 4. DISCUSSION

Environmental literacy is a widely accepted concept that has been subject to investigation along the past few decades. Knowledge, attitude and behavior are considered the main components of environmental literacy and several studies showed their interrelationship as well with other variables like gender, age, socio-economic status and place of residence, among others. Since the 1980's, several theoretical models and frameworks have been developed in order to explain and understand environmental literacy concept and, those, help increasing the efficiency of environmental education through new and innovative strategies. The huge bulk of data collected through the research effort of past decades have been analyzed and interpreted in the scope of these theoretical frameworks, namely the Theory of Planned Behavior (Ajzen, 1988) and the model of Responsible Environmental Behavior (Hines et al., 1986/87), but, despite important progresses, environmental literacy still is a concept needing clarification and better understanding. In fact, besides economic, socio-cultural and demographic predictors, correlation studies between environmental literacy main components had shown incongruent results along different populations, as well, in the same population, along different variables (Hines et al., 1986/87; Ngev et al., 2008), confirming its complexity and multifactorial dependence.

Present study on environmental literacy components correlation among 9<sup>th</sup> grade students from Madeira Island (Portugal) reveals its known intricacy and asks for more and directed research. However, this investigation allows clear answers for each posed research question, showing that, among 9<sup>th</sup> grade students from Madeira Island, environmental literacy main components correlate each other positively and significantly in a small level, lower than hypothesized, revealing that, especially, place of residence (urban or rural), gender and performance on the 8<sup>th</sup> grade Natural Sciences discipline strongly influence these relationships. Therefore, the study seems to indicate that the correlation levels between knowledge, attitude and behavior are determined by different influences that act upon each specific environmental literacy group or single items and through population variables, making clear the difficulties to draw a clear picture of the environmental literacy framework. This could mean that each item participating in the construction of the environmental literacy components establishes different relationships depending on the individual and population characteristics. In fact, among 9<sup>th</sup> grade students from Madeira Island there are evidences of this intermingled and networking relationship since, for example, the correlation between the pro-NEP attitude concordance with 'fragility of nature's balance' and 'waste knowledge' is clearly higher among rural and male students than others. The inability to establish relevant correlation values between the specific knowledge in who to correctly perform environmentally responsible tasks and the adoption of those specific behaviors could be as well a consequence of other stronger factors at play. Also, supporting this analysis is a relatively high diversity of Pearson's correlation values, despite always in a coherent interval between small and medium positive relationships, which were found along the variables considered for the 9<sup>th</sup> grade student's population.

Despite the small levels of positive correlation generally found on present study, our results are supportive of previous models that intends to explain environmental literacy, in particular the Model of Responsible Environmental Behavior (Hines et al. 1986/87), since the established relationships among the studied components show us a pathway where knowledge has greater ease on changing attitudes ( $r=0.276$ ,  $p=0.000$ ) than behaviors ( $r=0.198$ ,  $p=0.000$ ), being behaviors more influenced by attitudes ( $p=0.224$ ,  $p=0.000$ ). Therefore, since the shared variances between the three main environmental literacy components are very small, other factors and components not evaluated on present study, namely situational factors, intention to act, personality factors, locus of control, personal responsibility and subjective norms, should play a major role among 9<sup>th</sup> grade students from Madeira Island. In addition, our findings on the correlation level's diversity among demographic variables could also partially mirror the effect of these unevaluated factors. In fact, these demographic variables seem to pool economic and socio-cultural contexts as we can see, for example, with the high influences that socio-economic status exert on student's performance (Taylor et al., 2009).

Has expected, the internal correlation levels between the group items of each environmental literacy components (knowledge, attitude and behavior) tends to be higher than among different components (see table 2), reaching large positive correlation values for some NEP group items. These results support the idea that each environmental literacy component (environmental knowledge, NEP attitude and environmentally responsible behaviors) is effectively an independent solid construct in which their internal different items are interdependent. In a concrete outcome to improve environmental education strategies, this could mean that the development of each environmental literacy component should benefit from an integrated approach since the different behaviors tend to support each other, as well the five NEP group items and even the majority of knowledge topics. Again, showing that these internal relationships could follow independent and specific influences and pathways for each component are the antagonistic results obtained on the internal correlation between water and wastes themes for knowledge and behavior. As we can see in table 2, water doesn't correlate

with wastes for knowledge ( $r=0.059$ ,  $p=0.19$ ) but correlates significantly at a medium positive level for behavior ( $r=0.304$ ,  $p=0.00$ ).

Present study is a minor contribution for an overall understanding of the environmental literacy concept but had the merit of open the research among students from Madeira Island. For now, it characterizes the relationships between environmental knowledge, NEP attitude and environmentally responsible behavior among 9<sup>th</sup> grade students from a specific region of Portugal, asking for new surveys that should consider other important factors that influence the environmental literacy levels, namely situational factors, intention to act, personality factors, locus of control, personal responsibility and subjective norms. Also, the demonstrated influence of demographic variables upon the correlation levels between the environmental literacy main components needs clarification, especially to understand why male, for attitude-behavior and knowledge-attitude, rural residence, for knowledge-attitude, and better performances in Natural Sciences discipline, for attitude-behaviors and knowledge-behavior, had the clear influence that was found. Intriguing, and also needing clarification in a next survey, is the neutral to negative influence of the Eco-Schools environmental education program on the correlation levels, when it was expected to be a variable that could act in a positive direction. The same for the participation in environmental activities at school, especially for knowledge-attitude correlation where our results showed a significant negative effect when it was expected to be positive. A future study should also address better the correlation between knowledge on environmentally responsible behavior strategies and the correspondent practical actions in order to confirm or not present results and, if yes, understand the reasons underlying the lack of relationships.

## 5. CONCLUSION

Evaluating the levels of correlation between the main environmental literacy components in different populations, and along their demographic and other variables, is an important contribution to better understand the pathway underlying the adoption of environmentally responsible behaviors, which environmental education so much intends to disseminate. As a contribution on that way, our findings on 9<sup>th</sup> grade students from Madeira Island corroborate previously developed models that intend to explain the relationship between environmental literacy components, showing that, on this specific population, they correlate in a small positive and significant level. Additionally, the complexity of the environmental literacy concept and of the pathway to environmentally responsible behaviors was confirmed, making clear that achieving environmental education goals is an exceptionally difficult task considering the intermingled network of multiple factors and influences at play. However, despite the need for further research on this population, present study identified a set of demographic variables that influences the relationships between environmental literacy components, as also several internal characteristics on those correlations that ask for future clarifications.

## ACKNOWLEDGMENTS

We thank the boards of the five elementary schools from Madeira Island that have authorized and cooperated with the present study, as also all the 9<sup>th</sup> grade teachers that applied the questionnaire in their classrooms.

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