

Article

Direct Experience of Nature as a Predictor of Environmentally Responsible Behaviors

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Abstract: A small but growing body of literature suggests that outdoor experiences during childhood affect environment-related behaviors in adulthood. However, research on the magnitude of the effect (effect size) of outdoor experience on learners' behaviors remains scarce. In this study, we explored the extent to which outdoor experiences are associated with environmentally responsible behaviors. Our sample consisted of 143 ninth- and tenth-grade students living on a Greek island. The data were collected using a properly adjusted environmental literacy instrument. Two different methodological pathways, i.e., a quasi-experimental approach and correlation analysis, were used to analyze the data. A tentative variable representing the frequency and intensity of students' experiential contact with nature was found to be the strongest available predictor of their self-reported pro-environmental behaviors. The findings of this study support the significance of outdoor, experiential learning during childhood in shaping individuals' environmental behaviors.

Keywords: environmental behavior; experiential learning; nature experience; outdoor learning; outdoor experience; experiential contact with nature



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1. Introduction

In the era of growing public awareness about the state and health of the natural environment, research on what causes people to act pro-environmentally is becoming increasingly urgent. A better understanding of the factors that lead people to adopt pro-environmental behaviors can help us to improve the quality of environmental and sustainability education (ESE). However, after 50 years of research in the field of environmental behaviors, the role and specific weight of factors that promote this type of behavior remain unexplored.

Initially, it was assumed that gains in environmental knowledge would lead to improved environmental attitudes, and eventually to the adoption of environmentally responsible behaviors [1,2]. This linear assumption became known as the knowledge–attitude–behavior (KAB) model [3]. However, this model was proven to be inadequate: research has shown that, in most cases, gains in environmental knowledge are not followed by direct improvements in environmental behavior [4].

Indeed, research in the field of ESE suggests that it is relatively easier to provide learners with ecological knowledge and/or knowledge of environmental issues than to influence their behaviors. In a recent study, Stern, Powell, and Hill conducted a meta-analysis of the literature reporting on the evidence-based outcomes of 86 environmental education programs (or groups of programs) in North America [5]. Although the programs that they reviewed were shown to be effective in improving learners' environmental knowledge, these gains in knowledge could not be linked to direct improvements in environmentally responsible behavior. Indeed, while 82% of the examined programs reported positive outcomes in environmental knowledge, and 37% of the programs reported positive outcomes in learners' environmental attitudes, only 16% of the programs reported

positive outcomes in improving learners' environmental behavior. On the other hand, those programs that included a strong outdoor component were more effective in changing learners' behaviors as compared to indoor, knowledge-based programs. These findings are consistent with the earlier influential meta-analysis of Hines et al., which concluded that the personality components of behavior prediction models—such as environmental attitudes and behavior—are not as readily influenced through educational efforts [6].

Decades of research on human psychology and behavior broadly recognize that knowledge gain is not typically a direct cause of behavior change [7,8]. In the field of environmental education, Hendee has characterized the assumption that knowledge could affect respective behaviors as the “folklore of environmental education” [9] (p. 1). Others have found that increased knowledge has a “trivial influence on future commitment” [10] (p. 38). Hence, scholars have urged us to be skeptical towards the idea that knowledge of environmental issues will lead to behavior change, which would then lead to a beneficial environmental impact. However, the insistence on this failed linear approach “continues to vex environmental education” [11] (p. 988).

The tenuous relationship between environmental knowledge and environmentally responsible behaviors has also been confirmed by recent research in program evaluation and planning [12,13]. Based on an environmental literacy comparison between eco-schools and ordinary schools in Slovenia, Krnel and Naglic concluded that, in the sample that they examined, an increased level of environmental knowledge “does not result in greater awareness and environmentally responsible behavior” [14] (p. 5). Their finding is consistent with Stern et al., who concluded in their meta-analysis that “programs that focus primarily on providing new knowledge should not be expected to necessarily influence behavioral outcomes, even though they may measure them” [5] (p. 23). Finally, in a recent environmental literacy study with Indonesian middle school students, Maulidya, Mudzakir, and Sanjaya concluded that “behavior is not influenced by the environmental knowledge, but more influenced by [student] attitude towards the environment” [15] (p. 193). Thus, if improving learners' environmental knowledge is not a sufficiently effective way to achieve behavioral change, what else might work?

1.1. Environmental Knowledge and Attitudes Explain Only a Small Part of the Variance in Environmental Behaviors

A considerable part of what we currently know about the relationship between environmental knowledge, environmental attitudes, and environmentally responsible behavior draws from an influential meta-analysis by Hines, Hungerford, and Tomera, released in 1987 [6]. In their meta-analysis, Hines et al. analyzed 128 studies, published as far back as 1970. The analyzed studies reported on baseline measurements of learners' environmental knowledge, attitudes, and behaviors. Twenty years after their original publication, the meta-findings of Hines et al. were empirically confirmed by Bamberg and Möser [16]. In 2019, Marcinkowski and Reid revisited these earlier works in a review article that focused on the relationship between knowledge, attitudes, and behaviors in environmental education [17].

Based on the mean correlation strengths reported by Hines et al. in 1987—and confirmed by subsequent research—the coefficient for the environmental knowledge–environmental behavior correlation is $r = 0.299$ [6,16,17]. This correlation strength corresponds to a small to moderate effect size for the K–B correlation, which suggests a relatively weak relation between environmental knowledge and behaviors. The A–B correlation ($r = 0.347$) is somewhat stronger as compared to the K–B correlation; however, this figure still corresponds to a moderate effect size [18]. On this point, Marcinkowski and Reid recently concurred that while the attitude–behavior relationship “may be statistically significant, it is often of relatively moderate strength only” [17] (p. 465).

After the realization that the knowledge to attitude to behavior path is inadequate in interpreting and achieving the espoused behavioral change [19] (p. 7), researchers moved on to explore alternative paths leading to the adoption of environmentally responsible behaviors. Other variables that were found to be associated with such behaviors were de-

mographic variables such as income and educational level, and personality variables such as personal responsibility and the locus of control [20]. Indeed, the locus of control is one of the variables with the highest correlation coefficients with environmentally responsible behavior. The locus of control represents an individual's perception of whether they have the ability to bring about change through their own behavior [21]. According to the correlation coefficients reported by Hines et al. in their original meta-analysis, the locus of control explains 13.3% of the variance in environmental behaviors ($r = 0.365$) [6]. Furthermore, Sia et al. reported a significant correlation ($r = 0.38, p < 0.05$) between the locus of control and environmentally responsible behavior [22]. Later on, Smith-Sebasto and Fortner also found a positive significant correlation ($r = 0.33, p < 0.01$) between these two variables [23]. Hsu and Roth also reported that the locus of control correlates with environmentally responsible behavior by $r = 0.27$ [24]. Hence, the locus of control is considered one of the strongest available predictors of environmentally responsible behavior. However, even if the locus of control demonstrates a stronger correlation with environmentally responsible behavior as compared to environmental knowledge or attitudes, we still do not have a clear idea of how to influence learners' locus of control assuming that this will have a secondary effect on their behavior. Even after the consideration of the—moderate in effect size—correlation of the locus of control with behaviors, most of the variance in environmentally responsible behaviors still remains unaccounted for.

1.2. Contemporary Research on Environmental Learning and Behavior Change

Since environmental knowledge, environmental attitudes, and the other measured variables explain only a small part of the variance in environmental behaviors, what else could predict environmental behaviors? What accounts for the remaining variance? Is there any additional factor that can help us to predict (with the end goal of improving) environmental behaviors? In their recent (2019) review of research on the attitude–behavior relationship, Marcinkowski and Reid [17] returned to the literature to discuss a situational factor that was overlooked by earlier research: direct experience. Delving into the non-environmental education literature, Marcinkowski and Reid [17] identified several personal and situational factors that serve as moderators of the attitude–behavior relationship, including social pressure, perceived difficulty [25], and whether “the attitude is formed by direct experience, the attitude is held with certainty” [26] (p. 1). According to Marcinkowski and Reid, direct, experiential learning is one of the situational factors (or situational moderators) that enhances the attitude–behavior correlation [17]. As they note, the attitude–behavior correlations “tend to be higher when the attitude is formed by direct experience” [17] (p. 466). Hence, Marcinkowski and Reid consider direct experience of nature as a situational moderator of the attitude–behavior relationship.

Eventually, one of Marcinkowski's former students, Mehmet Erdogan, proceeded to introduce experience in natural environments as an independent variable. For the needs of his doctoral research in Turkey, Erdogan designed a scale aiming to capture learners' exposure to direct, experiential learning [27]. Instead of treating direct experience of nature as a situational moderator of the A–B relationship, Erdogan introduced a variable that encompassed learning by direct experience as an independent predictor of learners' environmental behaviors. After studying the literature on the role of significant life experiences in shaping pro-environmental behaviors, Erdogan became interested in those experiences that are shaped by direct, experiential contact with nature. Erdogan's experience in natural environments variable comprises the frequency and intensity of learners' direct, experiential contact with nature, based on their reported participation in a number of natural activities, such as camping and trekking [27].

In Erdogan's sample, students who participated more frequently in outdoor activities in natural settings were more likely to adopt (and demonstrate) pro-environmental behaviors. Indeed, Erdogan reports experience in the natural environment as one of the strongest predictors of environmentally responsible behaviors in his research sample of ($n = 1545$) grade five students [27] (p. v). The purpose of the present study is to offer additional

evidence on whether this tentative variable can be considered as an effective predictor of pro-environmental behaviors in different data sets.

Erdogan's finding that experiential contact with nature influences environmental behaviors is not surprising. There is already a considerable volume of literature attesting to the role of significant life experiences and direct experiential contact with nature in shaping learners' environmental attitudes, concerns, behaviors, and life paths [28–33]. In his work with pre-school education students, Professor Georgopoulos noted that “greater contact with nature during childhood increases the likelihood of them adopting environmentally responsible behaviors as adults” [34] (pp. 159–160). Georgopoulos cited earlier works to substantiate this hypothesis [30,31,35–37]. In their cross-sectional study, Rosa et al. referred to a similar body of literature to make the case that direct contact with nature is positively associated with pro-environmental behaviors [38]. However, the papers that they used as reference studies were methodologically disparate and drew from different fields of knowledge, which impedes meaningful comparisons across research findings. More systematic evidence on the quantitative dimensions of the relationship between (a) experiential contact with nature and (b) environmentally responsible behavior might facilitate the comparability of findings by enriching the available methodological palette.

In the present study, drawing on the typology of an environmental literacy instrument developed for the needs of Erdogan's doctoral research in Turkey, we attempted to introduce a measure of learners' experiential contact with nature. The research question that the present research intends to inform is the following: to what extent do people who have more frequent and intense direct experiences of the natural environment have better attitudes towards the natural environment or demonstrate improved environmental behaviors?

2. Materials and Methods

2.1. Population and Research Settings

The empirical data presented in this study draw on environmental literacy measurements taken from a student population in the island of Kalymnos, Greece. Kalymnos is a rugged Greek island adjacent to Asia Minor, Turkey. The island of Kalymnos has a permanent population of 16,000 residents and a land area of 134.5 km²—for comparison, Kalymnos is four times smaller than the island of Montréal. The island's population density is 119 residents per square km, which makes it one of the most densely populated Greek islands [39].

The research sample was taken from the High School and Lyceum of Kalymnos. These are public schools with a capacity of 219 and 232 students, respectively, situated in the main settlement and commercial port of the island. The first school-based environmental education program in Kalymnos took place in 1992, following the enactment of the first law in support of environmental education in 1990 [40]. The environmental education program was offered for eight consecutive school years and concluded in the year 2000 with a publication featuring the island's endemic flora and fauna [41]. In the following years, Kalymnos' educational community embraced environmental education, which was documented by a number of publications featuring Kalymnos-based environmental education programs [42,43]. In this study, the students from Kalymnos reported on their participation in environmental education programs during their earlier schooling history.

2.2. Data Collection, Analysis, and Research Rationale

In October 2017, the Greek Environmental Literature Instrument (GELI—see the next section for details) was administered to three classes of grade 9 and three classes of grade 10 students in the island of Kalymnos. GELI is a twelve-paged questionnaire intended to collect information on participants' environmental knowledge, attitudes, and behavior, as well as information on their demographics and schooling history. All students of the three grade 9 classes and three grade 10 classes who were present at that time consented to participate in the research when the purpose of the study was explained ($n = 143$). At the time of the first data sampling visit, no students were actively taking part in the ESE program, since the ESE groups for that year had not yet been formed. Hence, the baseline

measurements were taken before part of the student population was exposed to ESE for the 2017–2018 school year.

The baseline (pre-test) levels of environmental literacy components within the student population were assessed; demographic variables and information about students' life stories were collected as well. In this methodological approach, the problem of environmental behavior prediction is informed by studying the relationships between the baseline levels of demographic variables (e.g., parental education level), situational variables (e.g., previous exposure to environmental education), and environmental literacy components (i.e., environmental knowledge, attitudes and behavior). Statistical inferences are made by assessing the extent to which the situational variables (which reflect students' learning experiences) are associated with the baseline levels of selected environmental literacy components (environmental knowledge, attitudes, and behavior).

In order to assess the influence of demographic and situational factors on students' current environmental literacy levels, a correlation analysis was performed. Data analysis included the construction of a correlation matrix in which all possible bivariate partial correlations between the baseline variables were tabulated. A two-way correlation analysis was performed and Pearson's r was calculated for all the statistically significant bivariate correlations, with the alpha level set at $\alpha = 0.05$.

After an interval of 6.5 months, a second data collection visit took place in May 2018, from the same student sample. By then, part of the student population had completed the ESE elective for the 2017–2018 school year. The initial purpose of the second round of data collection was to explore whether students' environmental literacy levels had changed after their exposure to the ESE elective [44]. However, for the needs of the methodological approach presented in this research article, the data collected in the second round of data collection (post-test data) were analyzed solely for reasons of validity and reliability.

2.3. Instrumentation

Environmental literacy instruments differ in the type and amount of environmental literacy components and sub-components that they include, depending on the theoretical framework that each instrument follows. Different instruments use adjacent definitions of environmental knowledge, attitudes, and environmentally responsible behaviors. The instrument that was applied for data collection was a slightly modified version of the Greek Environmental Literacy Instrument (GELI), developed at the University of Athens by doctoral student Julie Kyriazi for the needs of her doctoral research [45,46].

In her doctoral thesis, Kyriazi explained that the Greek Environmental Literacy Instrument (GELI) is influenced by the Erdogan and Ok (2011) typology, which includes 41 sub-components of environmental literacy [47]. In turn, this typology drew from earlier work, such as the Erdogan and Marcinkowski (2007) framework of environmental literacy sub-components [48]. In its final form, the GELI consists of 79 items that are assigned to one section of demographic information and three major components of environmental literacy: environmental knowledge, environmental attitude, and environmentally responsible behavior. Most of the items in the instrument's cognitive component cover principles of ecological science and global environmental issues, while a small number probe students' knowledge about nationwide environmental issues. The environmental attitude section of the instrument covers affective components and dispositions towards the natural environment, while the behavioral section refers to students' observable behaviors that relate to or affect the natural environment [45].

Two novel add-ons appear in the instrument (GELI) that Kyriazi developed in order to assess the environmental literacy levels of first-year Greek University students ($n = 1010$). The first add-on that appears in GELI is a Likert-type scale asking about students' current participation in outdoor activities. This add-on draws from Erdogan's work on experience in the natural environment [27,47]. Secondly, Kyriazi (2018) added—in her revised instrument—an open-ended question asking about the “presence of important figures and experiences in students' life stories” [45] (p. 66). Kyriazi was apparently influenced

by the literature that has substantiated the importance of significant life experiences in shaping learners' environmental behavior and concerns [45] (pp. 14–15). However, since the purpose of Kyriazi's doctoral research was to assess the baseline environmental literacy levels of first-year Greek University students in order to study (and propose improvements for) the teaching of ecology in formal education settings, she did not proceed to treat these situational variables as predictors of environmental literacy.

Eventually, due to independent doctoral research by Dr. Erdogan and Dr. Kyriazi, the employed instrument (GELI) was already enriched with the components of experience in the natural environment and significant life experiences. Before administering the instrument to the Kalymnos students, GELI was further modified by including an additional item that asked about students' previous participation in ESE during their schooling history—the intention was to examine whether previous exposure to ESE could possibly represent an uncontrolled source of variation for the quasi-experimental design.

As a result, three independent studies employed the following three innovations/novel components to the final instrument, producing the following variables: (a) experience in the natural environment [27], (b) significant life experiences [45], and (c) past exposure to ESE [44]. All three variables included an experiential learning signal. However, it is important to note that while (a) experience in the natural environment referred to students' current participation in outdoor activities, both (b) significant life experiences and (c) past exposure to ESE referred to students' past experiences. Below, we will provide the technicalities regarding how these novel variables were constructed and how they were employed for the purpose and needs of the present study.

Experience in the natural environment is intended to express the frequency and intensity of learners' experiential contact with nature at the time of measurement. This component refers to “activities that individual[s] are involved in their spare time in the natural region for recreation purposes (e.g., tracking, fishing, hunting, picnicking, canoeing, etc.)” [27] (p. 14). In this sense, the respective variable expresses students' interaction “with the natural, rural and pristine habitats” [35] (p. 21).

For the needs of this study, we constructed the variable based on what we had in hand: the respective component as it appeared on GELI. Erdogan's experience in the natural environment component initially consisted of nine items, each of which included four frequency levels for each activity (frequency of time spent in natural regions). However, for reasons of face validity, we omitted the items of hunting and fishing from the construction of the variable—this point can be revisited by future research. Further, the items on students' frequency of participation in team sports (basketball, soccer, etc.) and frequency of shopping in a mall were also omitted since these activities did not meet the criterion of interaction “with the natural, rural and pristine habitats” [35] (p. 21).

Hence, after excluding the four items for the reasons explained above, we constructed the variable by giving equal weight to each of the following outdoor activities: (a) hiking, (b) camping, (c) nature photography, (d) biking, and (e) other outdoor activity that met the interaction with the natural environment criterion [35]. We will henceforth refer to this algebraic construct as outdoor experience in order to distinguish it from Erdogan's variable, which was most probably constructed somewhat differently.

The significant life experiences component, introduced by Kyriazi, referred to specific events and experiences in students' lives that had an impact on their interest in or their sensitivity to environmental issues (students were also asked to describe these events and at what age they happened) and/or the presence of a specific figure in students' lives (relative, writer, environmentalist/ecologist, mythological hero, comic character, political leader, teacher, actor, or other) who had positively impacted them with respect to environmental protection (students were also asked to name this figure) [45]. The significant life experiences variable was constructed by adding the values of the binary responses that the students gave to these two equally weighted questions.

Lastly, past exposure to ESE was constructed based on student responses to a single item that was added to the instrument. The item requested information about students'

previous participation in school-based ESE programs. The past exposure to ESE variable was included on the basis that it reasonably conveyed a signal of outdoor, experiential learning in students' earlier schooling history.

In sum, GELI collects data that produce five numerical variables (environmental knowledge, environmental attitudes, environmentally responsible behavior, age, and academic performance—GPA), four categories of binary data (including gender and past exposure to ESE), nineteen categories of ordinal data (derived from Likert-type scales of parental educational level and others), and fourteen nominal categories of data.

3. Results

As discussed above, the present study focused on baseline measurements taken from a sample of 14- and 15-year-old students from Kalymnos, Greece, in order to assess the influence of demographic and situational factors on their current environmental literacy levels. A correlation analysis revealed all the possible interaction patterns (two-way correlations) among the variables included in the instrument.

Figure 1 presents all of the statistically significant two-way partial correlations that were identified among the variables measured, as extracted from the questionnaires that were completed by the students. Variables external to the KAB model are classified as either demographic (on the upper half) or situational variables (on the lower half of the graph). All correlations are positive except for the correlation between gender and outdoor experience. Indeed, in this sample, female students are less likely to participate in outdoor activities but more likely to demonstrate increased academic performance as well as improved environmental attitudes. In order to make sense of the gender variable, in this study, female gender is, by convention, assigned a higher numerical value (see Table A1).

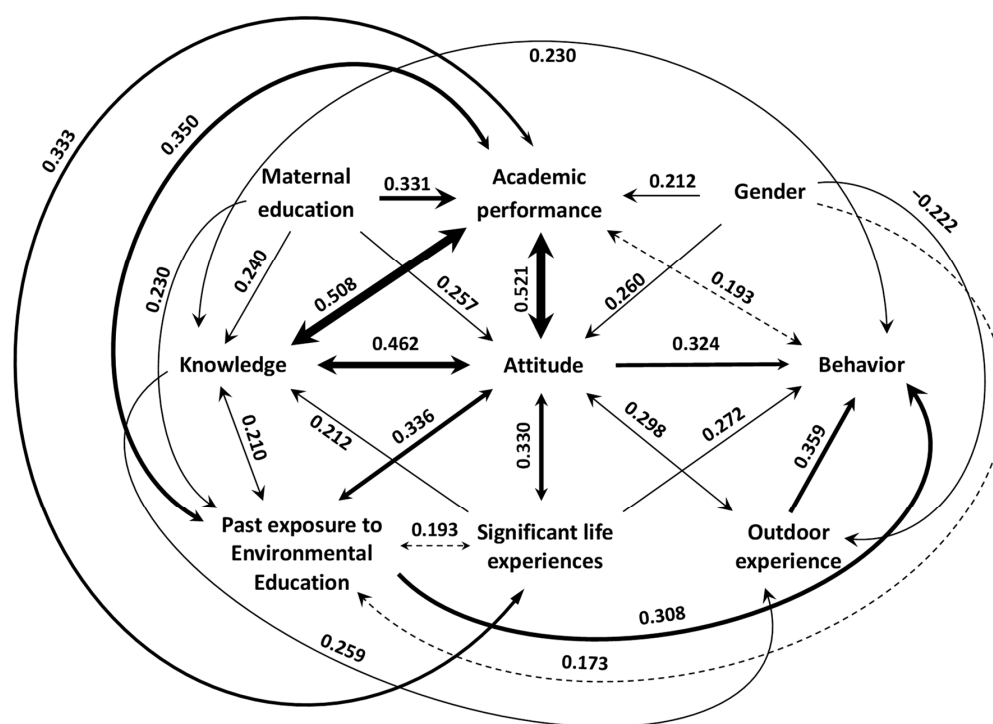


Figure 1. Bivariate partial correlations between the variables measured by the Greek Environmental Literacy Instrument (GELI) in the pre-test sample [N = 143]. The variables in the (environmental) knowledge–attitudes–behavior predictive string are considered as environmental literacy components. The variables at the upper part of the graph are treated as demographic variables, while the variables at the lower part of the graph are considered as situational variables. All featured correlations are statistically significant, with the alpha level set at $\alpha = 0.05$. The width of the arrows is proportional to the strength of the respective correlations (see the Table A1 for correlation coefficients).

The order of the correlation strengths between environmental knowledge to attitude to behavior concurs with the literature, indicating that the KAB model retains its relevance as an explanatory model—if not as a predictive string. However, the visual suggests that paths alternative to the KAB path are also present, as indicated by the correlation of pro-environmental behavior with outdoor experience and significant life experiences.

Observing the upper part of the explanatory model, it follows that the demographic variable with the highest impact on the beginning of the knowledge to attitude to behavior predictive string is academic performance (as represented by students' GPA). Indeed, a strong correlation appears between academic performance and the outcome variables environmental knowledge ($r = 0.508$) and environmental attitudes ($r = 0.521$).

However, academic performance and the cluster of demographic variables correlate only weakly with pro-environmental behavior, suggesting that other, more decisive factors prevail in shaping behavioral outcomes. Observing the lower part of the explanatory model, it appears that the most potent predictor of environmental behaviors available in the sample is outdoor experience ($r = 0.359$). The second most potent predictor of environmentally responsible behaviors in this student sample is environmental attitudes ($r = 0.324$).

The significant life experiences variable also correlates with environmental behaviors, but more strongly so with environmental attitudes. Students who have had significant environmental experiences in their early or later childhood are more likely to have improved environmental attitudes ($r = 0.330$) and environmental self-reported behaviors ($r = 0.272$) today. Further, it appears that students who took part in ESE during their early schooling demonstrated improved environmental attitudes and behaviors at the present time. Indeed, the correlation of past exposure to ESE and significant life experiences with the attitudinal component was somewhat stronger as compared to their correlation with the behavioral component. On the other hand, outdoor experience shows a stronger correlation with the behavioral end of the KAB string.

Past exposure to ESE and outdoor experience are oppositely crossed by the gender variable: more boys participate in outdoor activities in their free time, while more girls participate in school-based environmental education programs. In sum, however, the gender variable does not seem to correlate with environmental behavior: the genders are equally represented in pro-environmental behaviors.

Interestingly, all three variables that relate to experiential learning (past exposure to ESE, significant life experiences, and outdoor experience) correlate significantly with students' reported environmental attitudes and pro-environmental behaviors. However, there does not seem to be significant overlap between the three. Indeed, outdoor experience (participation in outdoor activities) does not correlate significantly with either significant life experiences or past exposure to environmental education. This means that students who took part in ESE during their early schooling or had important figures in their lives affecting their attitudes towards environmental issues did not demonstrate a higher participation rate in outdoor activities at the time of the study. Even though all three variables contained a signal of experiential learning, it is important to note that this signal was delivered to the students independently, in different temporal and social contexts.

3.1. Validity and Reliability

In studies where self-reported measures are taken, there is always the risk of social desirability affecting the answers. This threat to validity is common in the studies reviewed above and to which we compare our findings. Even though empirical data suggest that social desirability does not represent a significant validity threat in self-reported measures of environmental attitudes and behavior [49], it cannot be ruled out. This is why it is important to have converging evidence from different methodological traditions in support of the main findings.

A different validity threat ensues when a correlation between two variables owes to the influence exerted on both variables by a third variable. In this case, the effect of one variable can be mistaken as the effect of another. In order to address this threat to validity,

an intercorrelation matrix was constructed so as to reveal the interaction patterns between dependent, independent, and demographic variables [44]. Results from the intercorrelation matrix indicated whether it was meaningful to control for the effect of nuisance variables that may have acted as confounders of the explored relationships.

Indeed, a confounder does appear in the case of past exposure to ESE, which correlates significantly with academic performance (GPA) as well as with environmental knowledge, attitudes, and behavior, indicating that students who have been exposed to ESE in the past demonstrate improved environmental knowledge, attitudes, and behavior. However, the correlations of past exposure to ESE with both knowledge and attitudes drop below significance when academic performance (GPA) is controlled for. The only effect of previous exposure to ESE that can be supported after these corrections is on self-reported behaviors (albeit with reduced strength, $r = 0.202$). On the other hand, the correlation of outdoor experience and significant life experiences with self-reported behaviors survives the validity checks and remains unaffected by confounding variables: indeed, no significant validity threat was identified in the case of the correlations between outdoor experience, significant life experiences and the variables of interest.

Eventually, all three situational variables (that apparently convey the signal of experiential learning and unmediated contact with nature) correlate significantly with self-reported behaviors, even after the effect of nuisance/confounding variables is removed. Since school-based ESE in Greece often includes a strong outdoor component, the common thread connecting all three situational variables is experiential contact with nature.

3.2. Research Limitations

As is the case with many environmental literacy instruments, GELI does not cover the full scope of theoretically conceived environmental literacy components. For example, GELI omits three major environmental literacy components: environmental skills (practical environmental skills), environmental competencies (e.g., to identify, analyze, and propose solutions for environmental issues), and environmental awareness (e.g., awareness of the interdependence between biotic and abiotic ecosystemic components) [50]. Hence, the instrument assesses limited components of environmental literacy, and thus it cannot claim that it captures a comprehensive representation of students' environmental literacy.

However, this research limitation was overcome by the fact that the present research focused on environmental behavior, which is an environmental literacy component of special interest. Besides being an important environmental literacy component, environmental behavior (and the improvement thereof) is the intended outcome of ESE [51]. Specifically, the behavioral component of GELI differs from those of its preceding instruments in that it places an increased emphasis on learners' socio-political action. Early North American environmental literacy instruments such as Ciske, MSEL, and MSELs included few or no questions on learner empowerment and civic action. Instead, the behavioral components of these original instruments focused on individual environmental action; most of the questions in the instruments' behavioral part centered around learners' household-related behaviors, such as waste management routines at their homes or practices concerning the conservation of energy and tap water in their households [52] (p. 158). GELI's behavioral component, on the other hand, differs from the previous instruments in that it mostly comprises questions on learners' civic and community action. The difference is that, in GELI, most questions in the behavioral component inquire about learners' collective environmental behaviors [46] (p. 164). For example, GELI requests information on whether participants intervene when they notice that someone is actively harming the environment, as well as whether they spontaneously pick up litter to throw away in the rubbish bin and whether they take part in campaigns for the clean-up of public spaces and other civic life activities. The instrument was originally designed and validated with first-year university students; however, it was later shown to have adequate construct validity and ranges of values when applied to a 9th and 10th grade student population [44].

4. Conclusions

The findings presented here are internally consistent with an earlier quasi-experimental study that was based on the same data set [44,53]. In that (doctoral) study, a statistically significant improvement in students' environmental behaviors was observed after their exposure to outdoor, experiential learning over the course of 6.5 months. The students were exposed to three different outdoor environmental education programs during the 2017–2018 school year. According to the submitted lesson plans and published programmatic content, students learned about the geological history, freshwater sources, and environmental history of their island [42,43]. The outdoor part included visits to the islands' geological monuments and the islands' water facilities, as well as trekking on the ancestral trails connecting the island's villages. The programs' conclusion included an open presentation by the student groups where they proposed action strategies in order to protect the islands' walking trails, water resources, and geological monuments in the context of sustainable tourism and sustainable living.

In the findings of the doctoral study, it was demonstrated that the environment-related behaviors of students who participated in the aforementioned outdoor ESE programs during the 2017–2018 school year improved significantly compared to the control group (i.e., students who were not exposed to ESE). Indeed, in those quasi-experimental findings, a moderate (significant at the 99.5% confidence level) improvement in self-reported behaviors was recorded after the students were exposed to 6.5 months of outdoor environmental education as compared to a control group. The effect size (a 9% improvement) appears plausible when compared with the effect of past exposure on present-day environmental behaviors. Past exposure accounts for a 4.1% improvement in (pre-test) environmental behaviors, after adjusting for the effect of confounding variables. Indeed, it is to be expected that the effect of ESE (and its experiential learning component) wanes to some extent, unless the signal is renewed (Figure 2).

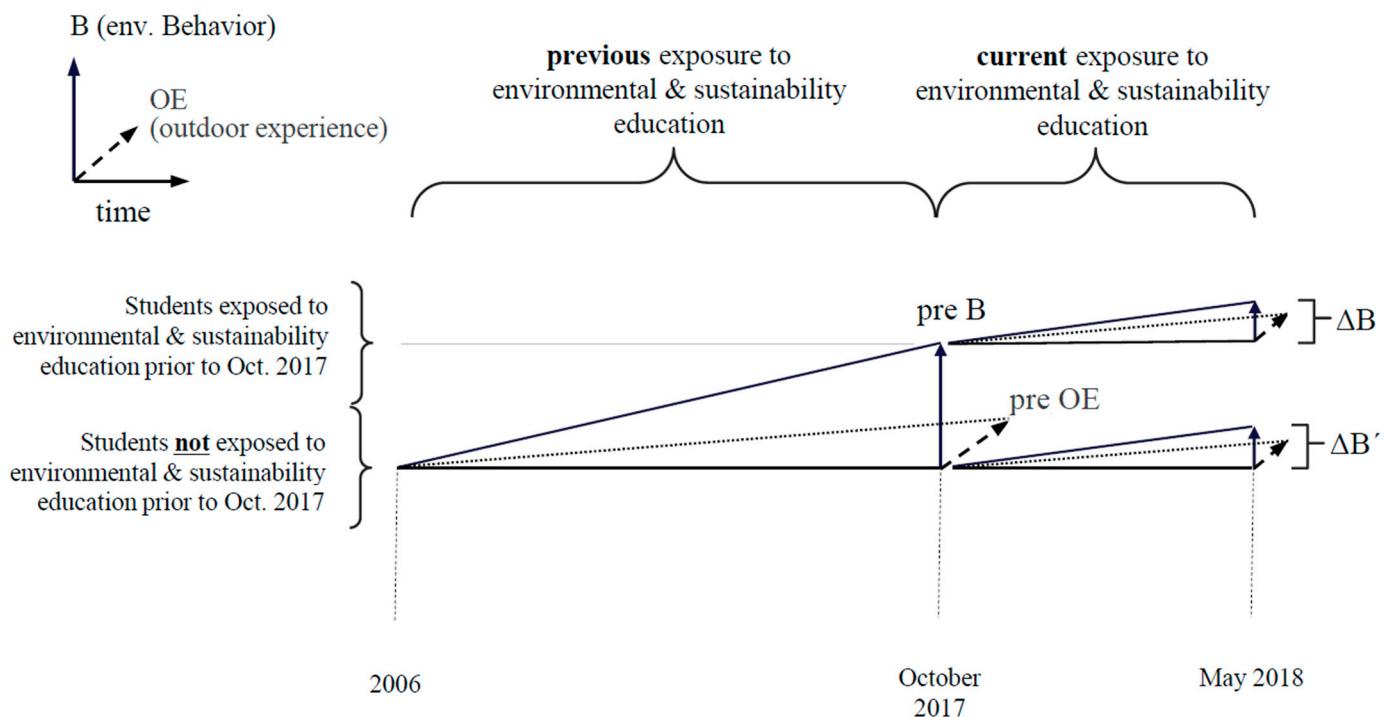


Figure 2. The primary analysis presented in this paper uses data collected in October 2017 and refers to the effect of antecedent influences on students' baseline environmental behaviors. On the other hand, ΔB is the observed improvement in environmental behaviors, after an educational intervention that started after October 2017. The effects of that educational intervention are discussed in Yanniris, 2021 [44].

Hence, our data from Kalymnos can serve two distinct approaches concerning the relationship between outdoor experience and environmental behavior. One is the quasi-experimental approach, which measured the change in environmental literacy components in response to treatment that took place after October 2017 [44,53]. The results from the quasi-experimental approach (where a significant improvement in environmental behaviors was observed) are consistent with the ones from similar research by Bogner in Germany [54]. Research by Bogner and others aimed to capture the effect of ESE quasi-experimentally in meso-scale [55,56].

Another approach is the correlation analysis presented in the present research article. In our baseline data (collected in October 2017), outdoor experience explained 12.9% ($r = 0.359$) of the variance in environmental behavior (partial correlation). We can relate this finding to research in psychology that has demonstrated that outdoor experience during childhood is the strongest predictor of adult environmental concern [57] (p. 142). Moreover, earlier research based on a large sample ($n = 1545$) of grade five students suggests that experiences of natural regions (frequency of experiences) is the strongest available predictor of their environmentally responsible behavior [27] (p. v, pp. 155–156).

In conclusion, the empirical data from this study demonstrate that outdoor experience directly supports pro-environmental behavior. We can obtain from both the quasi-experimental and baseline data (as well as the relevant literature) a confirmation of the statement that we used as a hypothesis for the present research: “greater contact with nature during childhood increases the likelihood of them adopting environmentally responsible behaviors as adults” [34] (pp. 159–160).

Future research is needed to confirm this finding using different data sets. One available data set that could be used to compare the results reported in this study is Kyriazi’s large sample of first-year university students, where the research instrument (GELI) has already been applied [45]. We also encourage researchers to include a section that asks about students’ outdoor activities (hiking, etc.) in future environmental literacy assessment instruments internationally. By expanding the research rationale to broader data sets, we can test the relationship between outdoor experiential learning and environmental behaviors in different age groups and learning settings.

This study contributes to the body of research that explores the relationship between outdoor, experiential learning and environmentally responsible behaviors. Again, more research is needed in order to improve our understanding of the educational stimuli and learning mechanisms that lead to improved environmental behaviors.

These findings are in line with previous research that has used both qualitative and quantitative methods to demonstrate the significance of outdoor experience during childhood in shaping individuals’ environmental concerns and behaviors, including their participation in environmental action and the adoption of environmental life paths [29–31]. Further, experiential contact with nature has been shown to positively influence learners’ physical and mental health [58–62]. Based on these observations, parents and educators, as well as education specialists at various levels of decision making, are encouraged to provide children with more opportunities for direct, experiential contact with nature.

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Appendix A

Table A1. Correlation coefficients and levels of statistical significance of bivariate partial correlations between demographic and situational variables and baseline levels of environmental knowledge, attitudes, and behaviors (all correlations that are statistically significant at the 0.05 level are featured in Figure 1).

		Knowledge (Max: 42)	Attitudes (Max: 60)	Behaviors (Max: 55)	Gender (1 = Girl, 0 = Boy)	Academic Performance (GPA)	Past exposure to Environmental and Sustainability Education	Maternal Education Level	Outdoor Experience	Significant Life Experiences
Knowledge (Max: 42)	Pearson	1	0.462 **	0.230 **	−0.058	0.508 **	0.210 *	0.240 **	0.259 **	0.212 *
	Correlation		0.000	0.007	0.492	0.000	0.013	0.004	0.003	0.012
	Sig. (2-tailed)									
	N	141	131	135	141	135	139	140	129	141
Attitude (Max: 60)	Pearson	0.462 **	1	0.324 **	0.260 **	0.521 **	0.336 **	0.257 **	0.298 **	0.330 **
	Correlation									
	Sig. (2-tailed)									
	N	0.000		0.000	0.002	0.000	0.000	0.003	0.001	0.000
		0131	133	128	133	128	131	132	123	133
Behaviors (Max: 55)	Pearson	0.230 **	0.324 **	1	0.047	0.193 *	0.308 **	0.101	0.359 **	0.272 **
	Correlation									
	Sig. (2-tailed)									
	N	0.007	0.000		0.587	0.026	0.000	0.241	0.000	0.001
		135	128	137	137	132	135	136	125	137
Gender (1 = girl, 0 = boy)	Pearson	−0.058	0.260 **	0.047	1	0.212 *	0.173 *	0.007	−0.222 *	0.156
	Correlation									
	Sig. (2-tailed)									
	N	0.492	0.002	0.587		0.013	0.040	0.936	0.011	0.063
		141	133	137	143	137	141	142	131	143
Academic performance (GPA)	Pearson	0.508 **	0.521 **	0.193 *	0.212 *	1	0.350 **	0.331 **	0.083	0.333 **
	Correlation									
	Sig. (2-tailed)									
	N	0.000	0.000	0.026	0.013		0.000	0.000	0.357	0.000
		135	128	132	137	137	135	136	126	137
Past exposure to environ- mental and sustainability education	Pearson	0.210 *	0.336 **	0.308 **	0.173 *	0.350 **	1	0.230 **	0.166	0.193 *
	Correlation									
	Sig. (2-tailed)									
	N	0.013	0.000	0.000	0.040	0.000		0.006	0.060	0.022
		139	131	135	141	135	141	140	129	141
Maternal education level	Pearson	0.240 **	0.257 **	0.101	0.007	0.331 **	0.230 **	1	−0.032	0.084
	Correlation									
	Sig. (2-tailed)									
	N	0.004	0.003	0.241	0.936	0.000	0.006		0.720	0.321
		140	132	136	142	136	140	142	130	142
Outdoor experience	Pearson	0.259 **	0.298 **	0.359 **	−0.222 *	0.083	0.166	−0.032	1	−0.003
	Correlation									
	Sig. (2-tailed)									
	N	0.003	0.001	0.000	0.011	0.357	0.060	0.720		0.971
		129	123	125	131	126	129	130	131	131
Significant life experiences	Pearson	0.212 *	0.330 **	0.272 **	0.156	0.333 **	0.193 *	0.084	−0.003	1
	Correlation									
	Sig. (2-tailed)									
	N	0.012	0.000	0.001	0.063	0.000	0.022	0.321	0.971	
		141	133	137	143	137	141	142	131	143

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

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