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Roles of Environmental System Knowledge in Promoting University Students' Environmental Attitudes and Pro-Environmental Behaviors

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Abstract: This study aims to investigate the role of environmental system knowledge in promoting pro-environmental behaviors. Relationships between environmental knowledge and environmental attitudes as well as environmental knowledge and pro-environmental behaviors were analyzed. Environmental system knowledge includes knowledge of political ecology, sustainable development, environment and ecology, and environmental situations. This study included 128 students enrolling in the elective course entitled "Environment and Development" provided by the King Mongkut's University of Technology Thonburi in Bangkok city of Thailand and 150 students who were not participating in this course. The results revealed that environmental attitudes of students participating in the course was significantly higher than that of students not attending the course. Only knowledge of the environment and ecology highly correlated with environmental attitudes; on the other hand, diverse environmental knowledge significantly correlated with pro-environmental behaviors. The result also demonstrated that indirect impact environmental behaviors reported by both groups were statistically different, but there was no significant difference in direct impact environmental behaviors. This study suggested that environmental knowledge provided through a formal education could promote environmental attitudes, but it may not contribute to students' engagement in direct impact environmental behaviors.

Keywords: environmental knowledge; pro-environmental behaviors; environmental attitudes; political ecology; sustainable development

1. Introduction

Many higher education institutes have tried to promote students' pro-environmental behaviors (PEBs). Students are expected to participate in both direct and indirect impact PEBs. Direct impact PEBs include the acts that directly contribute to environmental improvements such as reuse and recycling behaviors and energy-saving behaviors; however, indirect impact PEBs refer to the acts that have no direct effects on better environmental change, but potentially shape the way how the environment is managed [1]. Indirect impact PEBs are include supporting environmental policy and preference to work with environmentally responsible organizations. Students could take an important role in bringing sustainability to the society by participating in both types of PEBs. Formal environmental education, such as providing environmental courses, has been used as one of important channels to educate students with environmental values and significance of environmental conservation and protection in order to promote environmental citizenship among university students [2,3]. The study of Pizmony–Levy & Michel [4] found that learning about environmentalism and sustainable issues in class

and being a member of campus-based environmental groups could promote student's participation in PEBs. Similarly, the study of Borchers et al. [5] found that environmental education could enhance people's environmental knowledge and attitudes towards nature. Jurdi–Hage et al. [6] suggested that to promote environmental literacy and students' sustainable life styles, students should learn about environmental knowledge, awareness, and critical thinking skills. Educating students with environmental knowledge that could promote positive ecological attitudes and students' engagement in PEBs is an important goal of environmental education [7–9], but it remains challenging. Though environmental knowledge is provided, students are still reluctant to engage in PEBs. Therefore, environmental education research that could support the development of effective environmental education is currently required [10].

With regard to value belief norm theory, environmental attitudes—defined as an individual's environmental worldviews—significantly influence PEBs [1,11]. Environmental attitudes represent people's beliefs about the interconnection between humans and the environment; thus, having positive environmental attitudes allow people to identify the negative consequences of behaviors for the environment. Consequently, they will construct a sense of obligation to act in an environment-friendly manner, which can, in turn, lead to a decision to engage in PEBs. Many previous studies affirmed that having positive environmental attitudes eventually leads to a decision to participate in PEBs [12–14], and most of those studies applied the New Ecological (Environmental) Paradigm proposed by Dunlap et al. [15] to measure individuals' environmental attitudes. The study of Abun & Aguot [16] revealed that eco-centric concern attitude could promote people's engagement in environmental movement activism and conservation behavior. Similarly, the study of Kim et al. [17] and Kukkonen et al. [2] revealed that if they have greater emotional empathy toward nature, people are more likely to participate in PEBs. However, some studies also found a weak relationship between environmental attitudes and PEBs [18–20]. Vermeir and Verbeke's [21] study demonstrated that environmental attitudes alone were a poor predictor of PEBs. Manaktola and Jauhari [20] discovered that though having positive attitudes toward environment-friendly practices in the hotel industry, customers did not translate their attitudes into a willingness to pay more for taking services from green hotels. However, PEBs can be predicted by diverse factors. Literature review suggests diverse viewpoints of PEB predictors. Many scholars indicated that PEBs were strongly predicted by social factors such as social relationships and social network [22,23]. Some scholars strongly believed that participation in PEBs was predicted by normative goals, intention, and gain [1,24,25]. For instance, the study of Heeren et al. [26] revealed that environmental knowledge was not as important as social norms, attitudes toward PEBs, and perceived capability to perform PEBs to promote American students' participation in PEBs. Many studies also revealed significant roles of socioeconomic characteristics in predicting PEBs. Those socioeconomic factors included gender [27], age [28], educational level [29], and income [30].

Regarding students' participation in PEBs, environmental knowledge could play an important role in cultivating students' positive environmental attitudes and PEBs [12,31–33]. Environmental knowledge can be generally defined as any information that constitutes the formation of environmental attitudes and people's participation in environmental behaviors [18]. Put differently, environmental knowledge can be defined as people's capability to identify numerous ecological symbols, concepts, and characteristics of behavior concerning environmental protection [34]. Hines et al. [35] defined two types of environmental knowledge, including knowledge of environmental phenomena and knowledge of environment-friendly action strategies. Several studies referred environmental knowledge as knowledge of environmental issues [33,36,37] and problem-solving actions and strategies [18,38]. Fryxell and Lo [39] defined environmental knowledge as environmental issues and general environmental knowledge about the facts, concepts, and relationships in the surrounding environment and ecosystems. Mostafa [36] also conceptualized environmental knowledge as people's understanding of environmental influence, environmental values and appreciation, negative relationships potentially destroying the environment, and collective responsibility.

In terms of knowledge measurement, environmental knowledge is divided into two types, including subjective and objective knowledge [31]. Subjective knowledge refers to people's own perception of understanding about the environment, whereas objective knowledge refers to actual knowledge that people possess [40]. Martin and Simintiras' [41] study found no correlation between these two types of knowledge. People's misunderstanding of their actual knowledge might cause ineffective decision making to take environmental actions. In terms of scale, environmental knowledge can be classified into two types: general environmental knowledge and specific knowledge [12]. General environmental knowledge is defined as "general knowledge of facts, concepts, and relationships concerning the natural environment and its major ecosystems," while specific environmental knowledge means knowledge relevant to particular environmental issues such as knowledge and behavioral consequences related to particular environmental behavior [39]. Taufique et al.'s [42] study measured levels of general knowledge by analyzing the degree to which people are familiar with contemporary pressing environmental issues, such as "climate change," "greenhouse gas," etc. Previous studies revealed diverse findings regarding the impact of both general and specific environmental knowledge on PEBs. Ellen [43], Frick et al. [10], and Ogbeide et al. [44] found in their studies that specific environmental knowledge has a more significant impact on environmental behavior. The study of Polonsky et al. [12] revealed that both general and specific environmental knowledge levels assist US consumers in making environment-friendly consumption decisions. A more recent study by Taufique et al. [42] found that both general environmental knowledge and issue-specific environmental knowledge (e.g., eco-label knowledge) positively influence consumer attitudes toward the environment in driving ecologically conscious consumer behavior.

In universities, several environmental knowledge-related subjects are taught to students to cultivate their understanding of ecological values, problems, awareness, and preferred environmental practices, but the actual contribution of that educated knowledge to positive environmental attitudes and engagement in diverse types of PEBs is not clear. While many previous studies have investigated the relationship between environmental knowledge and attitudes, as well as association among environmental knowledge, attitudes, and behaviors, it was noticed that environmental knowledge explored by those studies was mostly investigated based on measurement of subjective knowledge, which may not reflect their actual knowledge (objective knowledge). Kaiser and Fuhrer [38] also added that the influence of environmental knowledge on pro-environmental behavior has been underestimated because the underlying structure of environmental knowledge has not been addressed adequately. They suggested that it is necessary to consider different forms of environmental knowledge to understand their effects on pro-environmental behavior.

This study aims to investigate how several types of environmental system knowledge taught in a university are essential to promote students' environmental attitudes and PEBs including both direct and indirect impact PEBs. The study also explores whether positive environmental attitudes are associated with students' participation in both types of PEBs and investigates types of environmental system knowledge that correlate with environmental attitudes and PEBs. Objective environmental knowledge of students will be measured based on the evaluation of actual knowledge acquisition. Namely, students will be taught environmental knowledge, and their knowledge will be tested. Types of environmental knowledge included in this study are knowledge of political ecology, sustainability, natural characteristics of the environment and ecology, and knowledge of environmental situations. The results of this study clearly indicate whether environmental knowledge could affect students' environmental attitudes and PEBs and provide an implication for developing an effective environmental education.

2. Roles of Environmental Knowledge in Promoting Environmental Attitudes and Pro-Environmental Behaviors

2.1. Types of Environmental Knowledge

Kaiser and Fuhrer [38] and Frick et al. [10] suggest that environmental knowledge can be classified into three types: system knowledge, action knowledge, and effectiveness knowledge. System knowledge refers to the natural characteristics of environmental and ecological systems regarding the relationship between organisms and ecosystem functions. It also includes human-environment relationships such as causes of environmental problems due to human development systems. For instance, people educated with this type of knowledge should be able to understand why carbon dioxide (CO_2) is a problem, where groundwater comes from, why ozone is a problem, and how long it will take for complete regeneration of the ozone layer after all ozone-destroying emissions are eliminated [10]. Dietz et al. [45] propose that to manage resources at an organizational level sustainably, responsible organizations should acquire this type of knowledge including both resource systems and human-environment interactions to understand natural variability, uncertainty, and the relative causes of and effective solutions to environmental change. Berkes et al. [46] add that the combination of different knowledge systems potentially contributes to effective judgment on the ways to tackle environmental change. Moreover, Díaz–Siefer et al. [47] found that at an individual level, environmental system knowledge focusing on global environmental problems closely related to pro-environmental behavior of students.

Action knowledge is relevant to behavioral choices and course of environmental actions that can reduce the environmental problems we face [10]. Other scholars also define action knowledge as a type of environmental knowledge that should be understood by individuals and organizations to create the capacity to minimize and eliminate environmental problems [18,38]. People educated with this knowledge should be able to understand the types of actions that potentially solve environmental problems. Effective knowledge refers to the effectiveness of environmental actions or behaviors in solving environmental problems or protecting the environment. It emphasizes the qualification of actions that can contribute to the greatest environmental benefit [10]. For instance, people educated with these types of knowledge should be able to recognize the types of packing that is the most or least damaging to the environment.

It can be stated that action and effective knowledge potentially enhance people's capacity to perform PEBs and could finally contribute to people's decision to participate in PEBs. The results concerning the influence of system knowledge on people's environmental attitudes and behaviors are diverse. Frick et al. [10] indicated no effect of system knowledge on PEBs. In contrary, other scholars noted the possibility of system knowledge to influence PEBs [48,49]. System knowledge can enhance people's understanding of environmental values as well as the interaction between human and nature; thus, environmental attitudes can be formed, leading to the decision to engage in PEBs. Fielding and Head [49] suggested that human-environment system knowledge can induce an internal locus of control in relation to the environment and/or guilt for the environment, which is known to improve PEBs.

Considering types of system knowledge that are in the environmental discipline, several concepts and issues reflecting both environmental and ecological systems and functions (geography-environment system knowledge) and environmental problems caused by human development systems (human–environment system knowledge) have been developed and taught in environmental courses. Political ecology and sustainable development are the concepts relevant to the human–environment system knowledge; on the other hand, the knowledge issues relevant to geography–environment system knowledge are basic knowledge of environmental and ecological systems and the current state of environmental situations. These concepts and issues can be explained as follows:

Political ecology is the concept that illustrates the interconnection between environmental and political, socio-economic conditions [50]. The concept addresses the contribution of state policies to

land use and environmental change and the ways global forces influence national, regional, and local scales of environmental governance [51].

Sustainable development (SD) is the concept that relates environmental issues with economic and social development [52]. The concept was published in Brundtland Report and disseminated in 1987 by the World Commission on Environment and Development. In the Brundtland Report, SD was conceptualized as "the development that meets the needs of the present without compromising the ability of the future generations to meet their own." [53]. More simply, the concept of SD refers to the development approach that aims to reach a dynamic equilibrium between the social and economic aspects while caring for the natural environment [54].

Concepts related to environment and ecology refer to the fundamental understanding of environmental characteristics and ecological systems. Ecology is the scientific knowledge of interactions among organisms and their environment. The concept also provides an understanding of diverse ecosystems and their functions. The environmental characteristics focus on the interactions among the chemical, biological, and physical components of the environment and the effects of these interactions on all types of organisms [55].

Environmental Situations refer to knowledge relevant to environmental issues, including global and local environmental problems, which have concerned the general public and society. These problems include climate change, global warming, ozone depletion, depletion of natural resources, deforestation, and loss of biodiversity [56]. This includes scientific knowledge explaining the causes of environmental problems, their situations, potential impacts, and effective solutions.

2.2. Relationship between Environmental Knowledge, Environmental Attitudes, and Pro-Environmental Behaviors

The relationship between environmental knowledge and environmental attitudes has been widely explored across the world. The results are diverse, depending on regions and types of PEBs. Some studies found a strong relationship between knowledge and positive environmental attitudes [32,57,58]. Conversely, it has also been contended that high levels of individual environmental knowledge may not necessarily lead to the development of positive environmental attitudes [59]. The study of Kollmuss and Agyeman [18] and Olli et al. [19] revealed a weak relationship between environmental attitudes and PEBs. Arcury [60] applied NEP (New Environmental Paradigm: Dunlap and Van Liere 1978) to measure environmental attitudes, and their results showed a positive relationship between knowledge and attitudes, up to $r = 0.33$. Similarly, Bradley et al. [61] investigated the effect of environmental science knowledge on environmental attitudes of students. The result revealed that attitudes significantly correlated with knowledge in the pre-test (Pearson's $r = 0.19$ with $p = 0.004$) and the correlation value also increased in the post-test (Pearson's $r = 0.27$ with $p < 0.001$), after learning program participation.

Environmental knowledge is also found to correlate with PEBs. Environmental knowledge can enhance people's capability as well as drive their motivation to perform PEBs. In addition, knowing current environmental situations could allow people to construct environmental concerns and a sense of urgency, which would, in turn, affect their decision to take environmental actions. Barber et al. [31] stated that people who have greater knowledge of environmental problems would be more motivated to act toward the environment in more responsible ways. Conversely, inadequate knowledge or having contradictory environmental information potentially limit PEBs [62]. Many studies insisted that having a more in-depth knowledge of environmental issues enhances individuals' likelihood to participate in environment-friendly actions [18,38,63]. Oguz et al. [33] also supported this finding; namely, people with a proper understanding of environmental problems, relative causes, and potential impacts are more willing to behave responsibly toward the environment. Environmental knowledge potentially contributes to people's formation of environmental awareness and concerns. Thus, the decision to participate in PEBs can be consequently made [25,64]. Barber et al. [31] also added that knowing environmental problems and actual causes allow people to construct motivation, leading to the decision to participate in PEBs. In contrary, many studies provided empirical evidence that there was no significant relationship between environmental knowledge and pro-environmental behavior [34,65].

For instance, Bartiaux [65] and Oguz et al. [33] demonstrated that although people acquired knowledge of environmental issues, their knowledge did not positively correlate with their environmental actions.

3. Hypotheses

This study will first investigate whether environmental system knowledge contributes to university students' environmental attitudes and PEBs by comparing levels of environmental attitudes and PEBs reported by university students who were taking environmental course and who were not taking the course. PEBs in this study include direct and indirect impact environmental behaviors. Stern [1] stated that direct impact PEBs refer to behaviors that directly contribute to environmental protection and/or improvement, and indirect impact PEBs refer to practices that indirectly promote or support environmental protection and/or improvement. For the investigation, this study selected PEBs that university students can practice on an everyday basis and are heavily promoted by the university. These behaviors are energy saving and sustainable waste management including waste separation, waste avoidance, and reuse and recycle activities. For indirect impact PEBs, this study investigates students' environmental policy support and environmental organization support. In consideration of environmental knowledge, this study will explore objective environmental knowledge, reflecting actual knowledge possessed by students. According to Kaiser and Fuhrer [38], environmental system knowledge refers to the following: (1) knowledge of environmental and ecological systems (geography–environment system knowledge) and (2) knowledge of environmental problems caused by human development systems (human-environment system knowledge). This study will explore four types of environmental contents—which reflect the core concept of system knowledge—on their contribution to environmental attitudes and PEBs. They include the concept of political ecology, SD, environment and ecology, and environmental situations. Such contents provide understandings on how environmental and ecological systems function, how each element in ecological systems is interconnected with the other, how the environment and human influence each other, and how the current environmental problems are. It is assumed that if students acquire these understandings, they will have a recognition of environmental values, awareness, concerns, and motivation to behave environmentally. Thus, students will have positive environmental attitudes and/or decide to participate in both direct and indirect ecological impact behaviors. The first research hypothesis is defined as follow:

Hypothesis 1. *Students who participate in the environmental course have more positive environmental attitudes and higher levels of PEBs (both direct and indirect environmental impact behaviors) than those who do not participate in the course.*

Second, the study will explore the correlation between environmental attitudes and PEBs including both direct and indirect impact PEBs. Many previous studies revealed diverse findings. This study assumes that students with positive environmental attitudes relatively engage in both types of PEBs at a significantly higher level. The research hypothesis is defined as follow:

Hypothesis 2. *Environmental attitudes highly correlate with direct and indirect impact PEBs.*

Third, the study will investigate types of environmental system knowledge (political ecology, SD, environment and ecology, and environmental situations), which could promote students' environmental attitudes and engagement in both types of PEBs. The research hypotheses are defined as follows:

Hypothesis 3. *Every kind of environmental system knowledge differently correlates with environmental attitudes.*

Hypothesis 4. *Each type of environmental system knowledge differently correlates with direct and indirect impact PEBs.*

4. Methods

4.1. Participants and Ethical Issue

Participants of this study were bachelor students of the King Mongkuts' University of Technology Thonburi, in Bangkok city, Thailand. The participants were divided into two groups including those who were taking an elective course entitled "Environment and Development" in the academic year of 2018 (experimental group) and those who were not taking this course (control group). Regarding the experimental group, there were 131 students enrolling in the course; however, 128 students decided to participate in this research. In addition, the simple random sampling method was applied to select the participants who were not taking this course. One hundred fifty participants were not taking this elective course, and these participants had similar characteristics with those who were taking the course. Namely, they relatively were in the same educational level and from the same academic disciplines. This research had received ethical approval from the ethical research community of the School of Liberal Arts. Before the data collection, all participants were informed about the research objectives, data collection methods, and the right to withdraw from the study and informed that their participation was voluntary. A group of participants enrolling in the "Environment and Development" course were additionally informed that their participation or non-participation would cause no impact on their academic performance evaluation.

Characteristics of participants in the experimental group and control are illustrated in Table 1. Participants in both groups had similar characteristics. The proportion of male participants in the experimental group and the control group were 40.63% and 43.3%, respectively. Female participants accounted for 59.38% in the experimental group and 56.7% in the control group. The average age of participants in both groups were almost equivalent, 21 years old. Their average grades were almost equivalent, 2.65 for the experimental group and 2.71 for the control group. Regarding the school level, most participants were in the third and fourth years of university level. The number of participants who were in other levels such as the second year or more than the fourth year was small in both the experimental and control group. The majority of participants in both groups were from the school of engineering and sciences, and a very small number of participants were from other schools such as technical education and information technology.

Table 1. Characteristics of participants.

Items	Experimental Group		Control Group	
	Mean/N	S.D./(%)	Mean/N	S.D./(%)
		Gender		
Male	52	40.63%	65	43.3%
Female	76	59.38%	85	56.7%
Age	21.44	0.82	21.38	0.77
Grade	2.65	0.44	2.71	0.46
		School level		
3rd year	11	8.6%	16	10.7%
4th year	108	84.4%	126	84.0%
Others	9	7.0%	8	5.3%
		Affiliation		
Engineering	61	47.7%	72	48.0%
Sciences	60	46.9%	66	44.0%
Others	7	5.50%	12	8.0%

4.2. Data Collection and Analysis

4.2.1. Measurement of Environmental System Knowledge

The experimental group, participants taking "Environment and Development" course, were taught about relevant environmental contends that included the concept of political ecology, SD, knowledge of environment and ecology, and environmental situations. These contents are normally taught in this course, but their contribution to promoting students' environmental attitudes and PEBs was never tested. The learning and teaching activities had lasted for seven weeks (three hours per week); after that, participants participated in the examination where their knowledge acquisition was evaluated based on their understanding. Characteristics of the test are demonstrated in Table 2. Each type of knowledge acquisition will be evaluated based on the scale of three ranging from 0 = no knowledge acquisition to 3 = full knowledge acquisition.

Table 2. Characteristic of environmental contents and tests.

Types of Environmental Contents	Characteristics of the Materials Taught in the Course	Questions in the Test
Political ecology	- Relationship between environmental problems and politics - Relationship between environmental problems and economic systems - Rights to use and manage natural resources - Environmental movements	- Regarding the concept of political ecology, please explain the influence of politics on the emergence of environmental problems. - How does each type of economic systems cause environmental problems? - Please explain why environmental movements have occurred in industrial development areas.
Sustainable development	- Three pillars of sustainability - Diverse SD approaches - Green growth & green GDP - Environmental sustainability - Indicators measuring sustainability in development	- Please explain the goal of SD. - What do environmental sustainability and green growth mean?
Environment and ecology	- Characteristics and components of environmental and ecological systems - Interaction among organisms in environmental and ecological systems - Ecological services	- Please explain the components of ecological systems and how they are related. - Please indicate the services provided by ecological systems.
Environmental situations	- Climate change - Ozone depletion - Pollution and solid waste problems - Ecological depletion	- Please explain how climate change, ozone depletion, air pollution, waste management problems, and ecological depletion occurred? - Please explain the potentially devastating consequences of those problems?

4.2.2. Measurement of Environmental Attitudes and PEBs

Questionnaire surveys were conducted with the experimental group and control group after teaching and testing activities were completed. Content validity of the questionnaire was performed based on face validity technique, and it has been tested with 20 students whose characteristics were similar to the sampling group. The questions used to measure environmental attitudes were applied from the New Ecological (Environmental) Paradigm proposed by Dunlap et al. [15]. Originally, the revised New Ecological Paradigm contains 15 items reflecting an individual's belief about human-nature relationship. In this study, in measuring students' environmental attitudes, only 6 items were selected based on the consideration of students' ability to interpret and understand the items. This could avoid errors in data collection. For measuring the participation in PEBs, participants were asked to indicate their frequency of involvement in a list of direct and indirect impact PEBs. Items for measuring students' participation in both types of PEBs were developed based on students' capability to perform and be involved in, and based on the current situation which some types of PEBs were being promoted by the university. Those were such as denying receiving a plastic bag when purchasing a few items from a convenient store or using cotton bags instead of plastic bags. Questions used for data collection are mentioned in Table 3.

Table 3. Variable, questions, and response categories.

Variables	Questions	
Environmental attitudes	The balance of nature is very delicate and easily upset.	1 = completely disagree 5 = completely agree
	Nature is strong. It can cope with the negative consequences caused by human activities.	1 = completely agree 5 = completely disagree
	Naturally, the existence of plants and animals is for human use.	
	The earth is like a spaceship with finite room and resources.	1 = completely disagree 5 = completely agree
	If things continue on their present course, we will soon experience a major ecological catastrophe.	1 = completely agree 5 = completely disagree
	Humans have the right to modify the natural environment to suit their needs.	
Participation in direct impact PEBs	Do you segregate waste before disposing it?	1 = never 5 = regularly
	Do you switch off the light or the air conditioner when you are not using it?	
	How often do you use cotton bags instead of plastic bags?	
	Do you deny receiving a plastic bag when purchasing a few items from a convenient store?	
	Do you purchase food or drinks using reusable containers?	
	How often do you reuse or recycle things such as plastic bags and bottles?	
Participation in indirect impact PEBs	To what extent do you agree that political leaders should have environmentally sustainable views?	1 = completely disagree 5 = completely agree
	I prefer to work with an organization that cares about the environment.	
	I support goods and services from enterprises that take care of the environmental issue in their business operation.	
	Both public and private organizations should have environmental strategies allied with organization goals.	

4.2.3. Data Analysis

All corrected data were inspected. The internal consistency of the scales, which were used for measuring environmental attitudes and PEBs, were tested by Cronbach's alpha. The results revealed that the values of Cronbach's alpha were above 0.7. This represents reliability of data gain form the surveys. Kolmogorov–Smirnov (K–S) tests were first performed to test the normality of distribution. Subsequently, a *t*-test was conducted to measure the difference in the mean of environmental attitudes and the engagement level in PEBs reported by experimental group and control group. Moreover, the analyses of correlation between environmental knowledge and attitudes, between knowledge and PEBs, and between attitudes and PEBs were analyzed by using SPSS 22 (Statistical Package for Social Sciences) software. Finally, the discussion of the results was carried out.

5. Results

5.1. Environmental Knowledge, Attitudes, and Pro-Environmental Behaviors (PEBs)

In Table 4, levels of engagement in direct and indirect impact PEBs, environmental attitudes, and environmental knowledge are reported. Levels of engagement in direct and indirect impact PEBs and environmental attitudes were analyzed based on data collected from questionnaire surveys with the measurement based on the scale of 1–5. Overall, participants reported a higher level of engagement in indirect impact PEBs than direct impact PEBs in many items. For environmental knowledge, participants' knowledge acquisition was evaluated based on a scale of 0–3. The results revealed that participants gained the highest average score in knowledge of political ecology; however, the average scores of knowledge of SD and environment and ecology were almost equivalent and relatively low. Moreover, Table 4 also demonstrates the reliability of the scales used in the questionnaire as measured by Cronbach's alpha. All the variables exhibited good reliability, with Cronbach's alpha values greater than 0.70. Therefore, the data gained from the survey were reliable and proper for statistical analyses.

5.2. Characteristics of Participants, Environmental Knowledge, Attitudes, and Pro-Environmental Behaviors (PEBs)

First, the Kolmogorov–Smirnov (K–S) tests were performed to test whether data regarding students' environmental attitudes, and levels of participation in both direct and indirect impact PEBs were normally distributed. The results revealed that the distribution of environmental attitudes met the normality assumption indicated by K-S; $Z = 0.72$, $p = 0.08$. The distribution of data regarding both direct and indirect impact PEBs also met the normality assumption indicated by K-S; $Z = 0.77$, $p = 0.09$ and $Z = 0.88$, $p = 0.10$ respectively. Then, the difference in mean scores of environmental attitudes and levels of engagement in PEBs reported by the experimental group and control group was analyzed by performing a *t*-test (see Table 5). The result revealed that students participating in the environmental course reported significantly higher levels of environmental attitudes (M = 3.44, SD = 0.46) than students who did not participate in the environmental course (M = 3.28, SD = 0.42), $t(276) = -3.09$, $p = 0.00$. It was also found that their self-reported engagement in indirect impact PEBs was also significantly different. Students participating in the environmental course had reported a higher level of indirect impact PEBs (M = 3.79, SD = 0.59) than students not participating in the environmental course ((M = 3.63, SD = 0.63), $t(276) = -2.20$, $p = 0.03$. There was no a significant difference in the level of engagement in direct impact PEBs reported by both groups. However, the mean score of engagement level in direct impact PEBs reported by the experimental group (M = 3.59, SD = 0.58) was slightly higher than ones reported by the control group (M = 3.51, SD = 0.51).

Table 4. Variables, questions, and statistics.

Variables	Items	N	Mean	SD.	Cronbach's α
Direct Impact PEBs	Do you segregate waste before disposing it?	278	3.48	0.78	0.801
	Do you switch off the light or the air conditioner when you are not using it?	278	4.42	0.74	
	How often do you use cotton bags instead of plastic bags?	278	3.06	0.98	
	Do you deny receiving a plastic bag when purchasing a few items from a convenient store?	278	3.91	1.05	
	Do you purchase food or drinks using reusable containers?	278	2.68	1.20	
	How often do you reuse or recycle things such as plastic bags and bottles?	278	3.72	0.96	
Indirect Impact PEBs	To what extent do you agree that political leaders should have environmentally sustainable views?	278	3.35	0.84	0.723
	I prefer to work with an organization that cares about the environment.	278	3.91	1.00	
	I support goods and services from enterprises that take care of the environmental issue in their business operation.	278	3.72	0.80	
	Both public and private organizations should have environmental strategies allied with organization goals.	278	3.84	0.80	
Environmental Attitudes	The balance of nature is very delicate and easily upset.	278	4.29	0.76	0.704
	Nature is strong. It can cope with the negative consequences caused by human activities.	278	3.36	0.90	
	Naturally, the existence of plants and animals is for human use.	278	3.08	0.97	
	The earth is like a spaceship with finite room and resources.	278	4.28	0.80	
	If things continue on their present course, we will soon experience a major ecological catastrophe.	278	2.33	0.92	
	Humans have the right to modify the natural environment to suit their needs.	278	2.80	0.90	
Environmental Knowledge	Political ecology	128	2.11	0.90	-
	Sustainable development	128	1.54	1.04	-
	Environment and ecology	128	1.59	0.92	-
	Environmental situations	128	1.89	0.82	-

Table 5. Results of *t*-test analysis (n = 278).

Dependence Variables		N	Mean	S.D.	df	Difference	*t*	*P*
Environmental attitudes	Control group	150.00	3.28	0.42	276	−0.16	−3.09	0.00
	Experimental group	128.00	3.44	0.46				
Direct impact PEBs	Control group	150.00	3.51	0.51	276	−0.09	−1.31	0.19
	Experimental group	128.00	3.59	0.58				
Indirect impact PEBs	Control group	150.00	3.63	0.63	276	−0.16	−2.20	0.03
	Experimental group	128.00	3.79	0.59				

5.3. Correlations between Environmental Knowledge and PEBs, Knowledge and Attitudes, and Attitudes and Pro-Environmental Behaviors (PEBs)

First, the result of correlation analysis revealed that environmental attitudes did not significantly correlate with both direct and indirect impact PEBs and had a significantly positive correlation with the knowledge of environment and ecology. However, the size of correlation was small, $r(127) = 0.24$, $P < 0.01$, two-tailed. Regarding direct impact PEBs, the result demonstrated that knowledge of environmental situations and political ecology had a positive correlation with direct impact PEBs, $r(127) = 0.43$, $P < 0.01$, and $r(127) = 0.27$, $P < 0.01$. Participants' engagement in indirect PEBs was significantly and positively correlated with knowledge of SD, $r(127) = 0.39$, $P < 0.01$. In addition, knowledge of political ecology and environmental situations were also significantly and positively correlated with indirect impact PEBs, $r(127) = 0.24$, $P < 0.01$, and $r(127) = 0.18$, $P < 0.05$. It was also found that each type of PEBs was significantly correlated with each other, $r(127) = 0.38$, $P < 0.01$. Moreover, most types of knowledge were also correlated with others. For instance, knowledge of political ecology significantly correlated with knowledge of SD, environment and ecology, and knowledge of environmental situations. The result of the analysis is depicted in Table 6.

Table 6. Means, standard deviation, and Pearson correlation matrix (n = 128).

	M	S.D.	1	2	3	4	5	6	7
1.Environmental attitudes	3.44	0.46	1						
2.Direct impact pro-environmental behaviors (PEBs)	3.59	0.58	−0.08	1					
3.Indirect impact PEBs	3.79	0.59	−0.10	0.38 **	1				
4.Political ecology	2.11	0.90	0.04	0.27 **	0.24 **	1			
5.Sustainable development	1.54	1.04	−0.06	0.14	0.39 **	0.35 **	1		
6.Environment and ecology	1.59	0.92	0.24 **	−0.03	0.03	0.37 **	0.14	1	
7.Environmental situations	1.89	0.82	−0.02	0.43 **	0.18 *	0.48 **	0.25 **	0.15	1

Note: ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level.

6. Discussion and Conclusions

First, the results of this investigation clearly revealed that there was significant difference in environmental attitudes and the engagement in indirect impact PEBs between students participating in the environmental course and students not participating in the course. A significant difference in students' engagement in direct impact PEBs was not found. Particularly, students who participated in the environmental course for seven weeks did not engage in direct impact PEBs at a significantly higher level than students who did not participate in the course. It is possible that a decision to act in an environment-friendly manner can be based on other more influential and diverse factors (e.g., infrastructure, motivation, sense of responsibility, and social norms) and require some time for students to act upon. Vicente–Molina et al. [62] suggested that motivation and perceived effectiveness of PEBs were very powerful to predict university students' engagement in PEBs. Heeren et al. [26] also

indicated environmental knowledge was important, but not as important as social norms, attitudes toward PEBs, and perceived capability to perform PEBs to encourage American students in PEBs engagement. Based on this study's finding, formal environmental education can greatly bring some positive change to students' environmental attitudes and influence them to partake in indirect impact PEBs. The engagement in indirect impact PEBs such as supporting environmental policy in organizations and supporting goods and services from responsible business sectors may require fewer efforts and greatly rely on one's cognitive judgment based on self-awareness. Therefore, the role of environmental knowledge in influencing indirect impact PEBs could be sufficiently influential. For the engagement in direct PEBs, environmental knowledge provided through a formal environmental education might not be strong enough to bring a positive change. This finding can be supported by the study of Varoglu et al. [66], which reported a moderate relationship between environmental knowledge and environmental attitudes of students in secondary school level in North Cyprus and found a weak relationship between environmental knowledge and PEBs.

However, this study did not find significant relationships between environmental attitudes and both of types of PEBs including direct and indirect impact PEBs. This means that students might not act in an environmentally responsible manner despite having high positive environmental attitudes. This result is consistent with the study of Mifsud [67], which investigated several types of environmental knowledge, environmental attitudes, and direct impact PEBs of students attending postsecondary institutions in Malta. The results revealed that students exhibited strongly positive toward the environment but reported their engagement in few positive environmental actions. Similarly, Paço and Lavrador [68] also reported a weak relationship between environmental attitudes and PEBs of students from the University of Beira Interior. Unlike the study of Mifsud [67] and Paço and Lavrador [68], an investigation carried out by Heyl et al. [69] revealed the potentiality of positive environmental attitudes in predicting PEBs of engineering students in a Chilean university.

For this study, it can be concluded that environmental knowledge provided through a formal environmental education can constitute students' environmental attitudes, but it is uncertain that the attitudes would turn to PEBs. Knowledge may influence PEBs through other variables such as motivation, social norms, and perceive self-efficacy, according to the suggestion of Vicente–Molina et al. [62]. The study of Mtutu & Thondhlana [70] and Heberlein [71] also exhibited that though having a positive environmental attitude, people may not always decide to participate in PEB because of external factors which are beyond the control of individuals. External factors, for instance, include infrastructure condition or access to relevant infrastructure. Students will engage in waste separation, if they can access to recycling bins. This study found that the result of *t*-test analysis demonstrated that students participating in the environmental course reported a significantly higher level of engagement in indirect impact PEBs than students who did not participate the environmental course, but a significant relationship between environmental attitudes and indirect impact PEBs was not found. It could imply that knowledge might influence indirect impact PEBs through other attributes. This finding contradicts with the study of Oreg and Katz–Gerro [72], which stated that environmental knowledge potentially fosters an environmental attitude, which in turn influences any environmental behaviors.

In consideration of types of environmental contents that potentially foster environmental attitudes and contribute to students' engagement in both types of PEBs, it is hard to find relevant works of literature that investigate roles of specific environmental content in promoting types of PEBs. Therefore, the discussion in this part will be made based on only the results found in the study. This study has revealed that students having a high level of knowledge related to environment and ecology relatively reported a high level of positive environmental attitudes; on the other hand, other types of environmental contents were not significantly correlated. While studying about environment and ecology, students would be taught about interactions among organism in environmental system, ecosystem function, and environmental services. Therefore, having this basic knowledge, students would have the potential to evaluate environmental values and susceptibility of the environment and ecological systems to human behaviors; thus, a positive attitude toward the environment could be

formed. For the knowledge relevant to students' engagement in direct PEBs, the result displayed that knowledge of environmental situations (e.g., the potential impact of climate change, pollution, ozone depletion, and ecological degradation) and knowledge of political ecology were positively and significantly correlated with such PEBs. It is possible that by understanding these issues, students could understand the seriousness of the current environmental problems and their root causes.

Consequently, a sense of urgency to take some actions can be constructed, and it can potentially affect students' decisions to perform environmentally. However, the result of *t*-test revealed no significant difference in the level of direct impact PEBs reported by students participating in the environmental course and students not participating in the course. This could be because knowledge of environmental situations and relevant knowledge of political ecology such as environmental politics were generally available in other informal sources such as media, public demonstrations about the environment, and environmental activities carried out by universities. The study of Zhang et al. [73] revealed positive relationships between news media use and people's engagement in two types of PEBs including environmental activism and consumerism. Similarly, Yu at. al. [74] indicated that people's understanding of environmental problems and media exposure significantly and positively contributed to the engagement in PEBs. However, to drive a significantly positive change in students' direct impact PEBs, other types of potential determinates should be further investigated, and environmental education should cooperate with those potential determinants.

Regarding indirect impact PEBs, the result revealed that knowledge of SD was moderately and significantly correlated with students' engagement in indirect impact PEBs. Knowledge of political ecology and environmental situations were also significantly correlated with such PEBs, but the relationships between them were weak. However, it could suggest that the combination of these environmental contents could allow students to recognize ultimate goals and benefits of SD in term of sustainably solving current environmental problems. Educated with knowledge of political ecology and environmental situations, students could understand several causes of environmental problems generated from political and socio-economic systems along with their seriousness. Students could, therefore, understand and recognize the significance of their roles in promoting sustainability goals through the support of environmental actions at an organizational level and regional level.

In conclusion, this study confirms a significant role of environmental knowledge and formal environmental education in fostering students' environmental attitudes and promoting indirect impact PEBs. However, students' engagement in direct impact PEBs (e.g., waster separation, energy-saving behavior, and reuse and recycling behaviors) cannot be enhanced by only students' participation in an environmental course. As found in the study of Geiger et al. [75], though people had a high level of both general and environmental knowledge such as knowledge of ecological systems, sustainability issues, effective actions and environmental situations, their engagement in PEBs was merely average. Several studies indicated the influence of other factors on PEBs engagement. Those are such as situational conditions [76], current behavior patterns [77], and also socioeconomic characteristics including gender [27], age [28], educational level [29], and income [30]. Students' engagement in direct PEBs can be also influenced by internal factors (e.g., awareness, personal norms, motivation, and perceived efficacy) and external factors (e.g., social norms and availability of infrastructure) [62,78].

However, it does not mean that environmental knowledge is not essential. This study demonstrated that students who possessed a high level of environmental situations and knowledge of political ecology relatively reported a higher engagement in direct PEBs, even though their relationships were not strong. Therefore, it could be suggested that both formal and informal environmental education should be provided in order to promote students' engagement in direct impact PEBs. This study also confirms that different types of environmental knowledge have distinct influence on each kind of PEBs. This conclusion is also supported by the work of Barber et al. [31], which also indicated that different types of environmental knowledge contributed to different types of environmental behavior. This study revealed that knowledge of environmental situations was the most significant in promoting direct impact PEBs, whereas knowledge of SD was most significant in supporting indirect impact PEBs.

However, no single knowledge can totally influence students' PEBs; therefore, a combination of diverse environmental knowledge is suggested. This study found that knowledge of political ecology, SD, and environmental situations positively correlated with indirect impact PEBs. Therefore, providing diverse environmental contents is suggested to develop an environmental course for promoting student's attitudes and environmental behaviors.

Finally, there is a limitation in this research which should be addressed. Majority of participants in this study were in third and fourth year of bachelor's degree, and all of them were studying in the field of sciences and technology. Therefore, the results might not be proper to generalize for all university students. For the recommendations for future research, it can be suggested that students' participation in PEBs can be influenced by diverse factors which should be comprehensively and deliberatively investigated. In addition, it is also important to develop effective strategies for organizing environmental courses which can finally encourage students to engage in PEBs. Therefore, research on environmental education with respect to content structure and learning tools for university students are heavily essential.

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References

1. Stern, P.C. Toward a coherent theory of environmentally significant behavior. *J. Soc. Issues* **2000**, *56*, 407–424. [CrossRef]
2. Kukkonen, J.; Kärkkäinen, S.; Keinonen, T. Examining the Relationships between Factors Influencing Environmental Behaviour among University Students. *Sustainability* **2018**, *10*, 4294. [CrossRef]
3. Arnon, S.; Orion, N.; Carmi, N. Environmental literacy components and their promotion by institutions of higher education: An Israeli case study. *Environ. Educ. Res.* **2015**, *21*, 1029–1055. [CrossRef]
4. Pizmony-Levy, O.; Michel, J.O. *Pro-Environmental Attitudes and Behaviors in Higher Education: Investigating the Role of Formal and Informal Factors*; Research Report; International and Transcultural Studies Unit, Columbia University: New York, NY, USA, 2018.
5. Borchers, C.; Boesch, C.; Riedel, J.; Guilahoux, H.; Ouattara, D.; Randler, C. Environmental education in Côte d'Ivoire/West Africa: Extra-curricular primary school teaching shows positive impact on environmental knowledge and attitudes. *Int. J. Sci. Educ. Part B* **2013**, *4*, 240–259. [CrossRef]
6. Jurdi-Hage, R.; Hage, H.; Chow, H. Cognitive and behavioural environmental concern among university students in a Canadian city: Implications for institutional interventions. *Aust. J. Environ. Educ.* **2019**, *35*, 28–61. [CrossRef]
7. Duerden, M.D.; Witt, P.A. The impact of direct and indirect experiences on the development of environmental knowledge, attitudes, and behavior. *J. Environ. Psychol.* **2010**, *30*, 379–392. [CrossRef]
8. Asunta, T. Knowledge of Environmental Issues. In *Where Pupils Acquire Information Opinions, and How It Affects Their Attitudes, and Laboratory Behavior*; University of Jyväskylä: Jyväskylä, Finland, 2003.
9. Harring, N.; Jagers, S.C. Why do people accept environmental policies? The prospects of higher education and changes in norms, beliefs and policy preferences. *Environ. Educ. Res.* **2017**, *24*, 791–806. [CrossRef]
10. Frick, J.; Kaiser, F.G.; Wilson, M. Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personal. Individ. Differ.* **2004**, *37*, 1597–1613. [CrossRef]
11. Stern, P.C.; Dietz, T.; Abel, T.; Guagnano, G.A.; Kalof, L. A value-belief-norm theory of support for social movements: The case of environmentalism. *Hum. Ecol. Rev.* **1999**, *6*, 81–97.

12. Polonsky, M.J.; Vocino, A.; Grau, S.L.; Garma, R.; Ferdous, A.S. The Impact of General and Carbon-Related Environmental Knowledge on Attitudes and Behaviour of US Consumers. *J. Mark. Manag.* **2012**, *28*, 238–263. [CrossRef]
13. Ballantyne, R.; Packer, J. Promoting environmentally sustainable attitudes and behavior through free-choice learning experiences: What is the state of the game? *J. Environ. Educ.* **2005**, *11*, 281–295.
14. Kotchen, M.; Reiling, S. Environmental attitudes, motivations, and contingent valuation of nonuse values: A case study involving endangered species. *Ecol. Econ.* **2000**, *32*, 93–107. [CrossRef]
15. Dunlap, R.E.; Van Liere, K.D.; Mertig, A.G.; Jones, R.E. Measuring Endorsement of the new ecological paradigm: A revised NEP scale. *J. Soc. Issues* **2000**, *56*, 425–442. [CrossRef]
16. Abun, D.; Aguot, F. Measuring Environmental Attitude and Environmental Behavior of Senior High School Students of Divine Word Colleges in Region, I., Philippines. *Int. J. Educ. Res.* **2017**, *1*, 33–69.
17. Kim, M.-S.; Kim, J.; Thapa, B. Influence of Environmental Knowledge on Affect, Nature Affiliation and Pro-Environmental Behaviors among Tourists. *Sustainability* **2018**, *10*, 3109. [CrossRef]
18. Kollmuss, A.; Agyeman, J. Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res.* **2002**, *8*, 239–260. [CrossRef]
19. Olli, E.; Grendstad, G.; Wollebaek, D. Correlates of environmental behaviours: Bringing back social context. *Environ. Behav.* **2001**, *33*, 181–208.
20. Manaktola, K.; Jauhari, V. Exploring consumer attitude and behavior towards green practices in the lodging industry in India. *Int. J. Contemp. Hosp. Manag.* **2007**, *19*, 364–377. [CrossRef]
21. Vermeir, I.; Verbeke, W. Sustainable food consumption: Exploring the consumer "attitude e behavioral intention" gap. *J. Agric. Environ. Ethics* **2006**, *19*, 169–194. [CrossRef]
22. Steg, L.; Vlek, C. Encouraging pro-environmental behaviour: An integrative eview and research agenda. *J. Environ. Psychol.* **2009**, *29*, 309–317. [CrossRef]
23. Theodori, G.L.; Luloff, A.E. Position on environmental issues and engagement in proenvironmental behaviors. *Soc. Nat. Resour.* **2002**, *15*, 471–482. [CrossRef]
24. Steg, L.; Bolderdijk, J.W.; Keizer, K.; Perlaviciute, G. An integrated framework for encouraging pro-environmental behaviour: The role of values, situational factors, and goals. *J. Environ. Psychol.* **2014**, *38*, 104–115. [CrossRef]
25. Bamberg, S.; Möser, G. Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *J. Environ. Psychol.* **2007**, *27*, 14–25. [CrossRef]
26. Heeren, A.J.; Singh, A.S.; Zwickle, A.; Koontz, T.M.; Slagle, K.M.; McCreery, A.C. Is sustainability knowledge half the battle? An examination of sustainability knowledge, attitudes, norms, and efficacy to understand sustainable behaviours. *Int. J. Sustain. High. Educ.* **2016**, *17*, 613–632. [CrossRef]
27. Xiao, C.; Hong, D. Gender differences in environmental behaviors in China. *Popul. Environ.* **2010**, *32*, 88–104. [CrossRef]
28. Dietz, T.; Stern, P.C.; Guagnano, G.A. Social structural and social psychological bases of environmental concern. *Environ. Behav.* **1998**, *30*, 450–471. [CrossRef]
29. Xiao, C.; McCright, A.M. A test of the biographical availability argument for gender differences in environmental behaviors. *Environ. Behav.* **2014**, *46*, 241–263. [CrossRef]
30. Poortinga, W.; Steg, L.; Vlek, C. Values, environmental concern and environmental behavior: A study into household energy use. *Environ. Behav.* **2004**, *36*, 70–93. [CrossRef]
31. Barber, N.; Taylor, D.C.; Strick, S. Environmental Knowledge and Attitudes: Influencing the Purchase Decisions of Wine Consumers. In Int. CHRIE Conference-Refereed Track. Event 16. 2009. Available online: http://scholarworks.umass.edu/refereed/Sessions/Wednesday/16 (accessed on 12 September 2018).
32. Flamm, B. The impacts of environmental knowledge and attitudes on vehicle ownership and use. *Transp. Res.* **2009**, *14*, 272–279. [CrossRef]
33. Oguz, D.; Çakci, I.; Kavas, S. Environmental awareness of university students in Ankara, Turkey. *Afr. J. Agric. Res.* **2010**, *5*, 2629–2636.
34. Laroche, M.; Bergeron, J.; Barbaro-Forleo, G. Targeting consumers who are willing to pay more for environmentally friendly products. *J. Consum. Mark.* **2001**, *18*, 503–520. [CrossRef]
35. Hines, J.M.; Hungerford, H.R.; Tomera, A.N. Analysis and Synthesis of Research on Responsible Pro-environmental Behavior: A meta-analysis. *J. Environ. Educ.* **1986**, *18*, 1–8. [CrossRef]
36. Mostafa, M.M. A hierarchical analysis of the green consciousness of the Egyptian consumer. *Psychol. Mark.* **2007**, *24*, 445–473. [CrossRef]

37. Aminrad, Z.; Zakariya, S.Z.B.S.; Hadi, A.S.; Sakari, M. Relationship between awareness, knowledge and attitudes towards environmental education among secondary school students in Malaysia. *World Appl. Sci. J.* **2013**, *22*, 1326–1333.
38. Kaiser, F.G.; Fuhrer, U. Ecological behaviour's dependency on different forms of knowledge. *Appl. Psychol. Int. Rev.* **2003**, *52*, 598–613. [CrossRef]
39. Fryxell, G.E.; Lo, C.W.H. The influence of environmental knowledge and values on managerial behaviours on behalf of the environment: An empirical examination of managers in China. *J. Bus. Ethics* **2003**, *46*, 45–69. [CrossRef]
40. Dodd, T.H.; Laverie, D.A.; Wilcox, J.F.; Duhan, D.F. Differential effects of experience, subjective knowledge, and objective knowledge on sources of information used in consumer wine purchasing. *J. Hosp. Tour. Res.* **2005**, *29*, 3–19. [CrossRef]
41. Martin, B.; Simintiras, A.C. The impact of green product lines on the environment: Does what they know affect how they feel? *Mark. Intell. Plan.* **1995**, *13*, 16–23. [CrossRef]
42. Taufique, K.M.R.; Siwar, C.; Chamhuri, N.; Sarah, F.H. Integrating General Environmental Knowledge and Eco-Label Knowledge in Understanding Ecologically Conscious Consumer Behavior. *Procedia Econ. Financ.* **2016**, *37*, 39–45. [CrossRef]
43. Ellen, P.S. Do we know what we need to know objective and subjective knowledge effects on pro-ecological behaviors. *J. Bus. Res.* **1994**, *30*, 43–52. [CrossRef]
44. Ogbeide, O.A.; Ford, C.; Stringer, R. The environmental benefits of organic wine: Exploring consumer willingness to pay premiums? *J. Food Prod. Mark.* **2015**, *21*, 482–502. [CrossRef]
45. Dietz, T.; Ostrom, E.; Stern, P.C. The struggle to govern the commons. *Science* **2003**, *302*, 1907–1912. [CrossRef]
46. Berkes, F.; Colding, J.; Folke, C. *Navigating Social-Ecological Systems*; Cambridge University Press: Cambridge, UK, 2003.
47. Díaz-Siefer, P.; Neaman, A.; Salgado, E.; Celis-Diez, J.L.; Otto, S. Human-Environment System Knowledge: A Correlate of Pro-Environmental Behavior. *Sustainability* **2015**, *7*, 15510–15526. [CrossRef]
48. Smith-Sebasto, N.J.; Fortner, R.W. The environmental action internal control index. *J. Environ. Educ.* **1994**, *25*, 23–29. [CrossRef]
49. Fielding, K.S.; Head, B.W. Determinants of young Australians' environmental actions: The role of responsibility attributions, locus of control, knowledge and attitudes. *Environ. Educ. Res.* **2012**, *18*, 171–186. [CrossRef]
50. Adams, W.M.; Hutton, J. People, parks and poverty: Political ecology and biodiversity conservation. *Conserv. Soc.* **2007**, *5*, 147–183.
51. Blaikie, P.H. *Brookfield Land Degradation and Society Meuthen*; Routledge: Abingdon, UK, 1987.
52. Corney, G.; Reid, A. Student teachers' learning about subject matter and pedagogy in education for sustainable development. *Environ. Educ. Res.* **2007**, *13*, 33–54. [CrossRef]
53. WCED. *Our Common Future: A Report from the United Nations World Commission on Environment and Development*; Oxford University Press: Oxford, UK, 1987.
54. Lozano, R. Incorporation and institutionalization of SD into universities: Breaking through barriers to change. *J. Clean. Prod.* **2006**, *14*, 787–796. [CrossRef]
55. Paquette, D.; Ryan, J. Bronfenbrenner's Ecological Systems Theory. 2001. Available online: http://pt3.nl.edu/paquetteryanwebquest.pdf (accessed on 30 July 2018).
56. Singh, R.L.; Singh, P.K. Global Environmental Problems. In *Principles and Applications of Environmental Biotechnology for a Sustainable Future*; Singh, R., Ed.; Applied Environmental Science and Engineering for a Sustainable Future; Springer: Singapore, 2017.
57. Thøgersen, J. Media attention and the market for 'green' consumer products. *Bus. Strategy Dev.* **2006**, *15*, 145–156. [CrossRef]
58. Gram-Hanssen, K. Standby consumption in households analyzed with a practice theory approach. *J. Ind. Ecol.* **2010**, *14*, 150–165. [CrossRef]
59. Diamantopoulos, A.; Schlegelmilch, B.B.; Sinkovics, R.R.; Bohlen, G.M. Can socio-demographics still play a role in profiling green consumers? A review of the evidence and an empirical investigation. *J. Bus. Res.* **2003**, *56*, 465–480. [CrossRef]
60. Arcury, T. Environmental Attitude and Environmental Knowledge. *Hum. Organ.* **1990**, *49*, 300–304. [CrossRef]

61. Bradley, J.C.; Waliczek, T.M.; Zajicek, J.M. Relationship between Environmental Knowledge and Environmental Attitude of High School Students. *J. Environ. Educ.* **1999**, *30*, 17–21. [CrossRef]
62. Vicente-Molina, M.A.; Fernández-Sáinz, A.; Izagirre-Olaizola, J. Environmental knowledge and other variables affecting pro-environmental behaviour: Comparison of university students from emerging and advanced countries. *J. Clean. Prod.* **2013**, *61*, 130–138. [CrossRef]
63. Kaiser, F.G.; Shimoda, T.A. Responsibility as a predictor of ecological behaviour. *J. Environ. Psychol.* **1999**, *19*, 243–253. [CrossRef]
64. Zsóka, Á.; Szerényi, Z.M.; Széchy, A.; Kocsis, T. Greening due to environmental education? Environmental knowledge, attitudes, consumer behaviour and everyday pro-environmental activities of Hungarian high school and university students. *J. Clean. Prod.* **2013**, *48*, 126–138. [CrossRef]
65. Bartiaux, F. Does environmental information overcome practice compartmentalisation and change consumers' behaviours? *J. Clean. Prod.* **2008**, *16*, 1170–1180. [CrossRef]
66. Varoglu, L.; Temel, S.; Yılmaz, A. Knowledge, Attitudes and Behaviours towards the Environmental Issues: Case of Northern Cyprus. *EURASIA J. Math. Sci. Technol. Educ.* **2018**, *14*, 997–1004. [CrossRef]
67. Mifsud, M.C. An Investigation on the Environmental Knowledge, Attitudes and Behavior of Maltese Youth US-China Education Review B. *Online Submiss.* **2011**, *3*, 413–422.
68. Paço, A.; Lavrador, T. Environmental knowledge and attitudes and behaviours towards energy consumption. *J. Environ. Manag.* **2017**, *197*, 384–392. [CrossRef]
69. Heyl, M.; Moyano Díaz, E.; Cifuentes, L. Environmental attitudes and behaviors of college students: A case study conducted at a chilean university. *Rev. Latinoam. Psicol.* **2013**, *45*, 487–500. [CrossRef]
70. Mtutu, P.; Thondhlana, G. Encouraging pro-environmental behaviour: Energy use and recycling at Rhodes University. *S. Afr. Habitat Int.* **2016**, *53*, 142–150. [CrossRef]
71. Heberlein, A.T. Navigating environmental attitudes. *Conserv. Biol.* **2012**, *26*, 583–585. [CrossRef]
72. Oreg, S.; Katz-Gerro, T. Predicting pro-environmental behavior crossnationally: Values, the theory of planned behavior, and value-belief-norm theory. *Environ. Behav.* **2006**, *38*, 462–483. [CrossRef]
73. Zhang, N.; Skoric, M.M. Media Use and Environmental Engagement: Examining Differential Gains from News Media and Social Media. *Int. J. Commun.* **2018**, *12*, 380–403.
74. Yu, H.; Ye, N.; Zhang, X. The Influence of Environmental Cognition on Pro-environmental Behavior: The Mediating Effect of Psychological Distance. Advances in Social Science. *Educ. Humanit. Res.* **2018**, *215*, 21–25.
75. Geiger, S.M.; Geiger, M.; Wilhelm, O. Environment-Specific vs. General Knowledge and Their Role in Pro-environmental Behavior. *Front Psychol.* **2019**, *10*, 718. [CrossRef]
76. Geiger, S.; Dombois, C.; Funke, J. The role of environmental knowledge and attitude: Predictors for ecological behavior across cultures? An analysis of argentinean and german students. *Umweltpsychologie* **2018**, *22*, 69–87.
77. Klöckner, C.A. A comprehensive model of the psychology of environmental behaviour-A meta-analysis. *Glob. Environ. Chang.* **2013**, *23*, 1028–1038. [CrossRef]
78. Liefländer, K.; Bogner, F.X. Educational impact on the relationship of environmental knowledge and attitudes. *Environ. Educ. Res.* **2018**, *24*, 611–624. [CrossRef]