sustainability

MDPI

Article

Examining the Relationships between Factors Influencing Environmental Behaviour among University Students

Jari Kukkonen *, Sirpa Kärkkäinen and Tuula Keinonen

School of Applied Educational Science and Teacher Education, University of Eastern Finland, Joensuu, P.O. Box 111, 8010 Joensuu, Finland; sirpa.a.karkkainen@uef.fi (S.K.); tuula.keinonen@uef.fi (T.K.)

* Correspondence: jari.kukkonen@uef.fi; Tel.: +358-029-445-2614

Received: 27 September 2018; Accepted: 15 November 2018; Published: 20 November 2018

Abstract: Education for sustainability may be seen as consisting of four dimensions: sensitivity and attitudes toward the environment, awareness and knowledge of the environment, environmentally friendly actions and participation. A questionnaire was drawn up which includes statements concerning all these dimensions and it was filled out by 674 university students from different majors. Data were analysed statistically and a structural equation model was formed. Results indicate that sensitivity toward or awareness of nature is the basis for the enjoyment of nature. The enjoyment of nature is directly positively related to the intention of support pro-environmental activity and to environmental knowledge. Furthermore, it has a mediational effect on ecological knowledge, concern, or the belief of human dominance over nature. Students who possess global concerns do not accept human dominance and this is related to the intent to support environmental activities. Students were found to form groups: "Sorters." "Occasional actors" and "Resource savers." Compared to prior research, due to the additional items concerning environmental sensitivity and awareness in our instrument, we were able to uncover the importance of sensitivity to the enjoyment of nature in the complex model of the relationships between awareness, attitudes, knowledge, concerns and intentions. Ecological knowledge leads to global concerns and, therefore, it should be promoted through science education.

Keywords: education for sustainability; environmental education; structural equation model

1. Introduction

Many scientific issues are challenging to learn and approaches to teaching such knowledge effectively are just emerging [1]. However, complex ideas, for example, issues regarding climate change, are taught during pre-university education, where students can be scaffolded to understand these concepts [2]. Further, it is suggested that in environmental education, environmental sensitivity should be promoted before conveying environmental knowledge [3,4]. Sensitivity toward the environment is developed particularly from experiences with nature and time spent in natural surroundings correlates positively with an individual's relationship to nature [5,6].

Several studies have focused on measuring environmental sensitivity, attitudes, awareness, knowledge of scientific issues, or intentions to act and their relationships have been evaluated using different tools. There is no common tool that measures attitudes toward the environment and sustainability because of the different theoretical backgrounds that underlie the various approaches [7]. The theory of planned behaviour suggests that behaviour is a function of the intent to act, as well as attitudinal evaluations of particular actions and related beliefs regarding behavioural outcomes [8–10]. The Responsible Environmental Behaviour model depicts an individual's intent

to act in an environmentally responsible manner as being dependent on a composite of cognitive- or personality-related variables: scientific knowledge of environmental issues, knowledge of action strategies combined with action skills, attitudes, locus of control and personal responsibility [11]. Hungerford and Volk [3] developed a model and further stated that three categories of factors linearly influence behaviour: entry-level variables (the major variable being sensitivity), ownership variables (e.g., ecological knowledge) and empowerment variables (knowledge of and skills in using environmental action strategies). The House model [4], largely used in Finnish environmental education, is based on the idea that the development of senses and emotions is crucial. The main aims in environmental education (to foster environmental sensitivity, to learn environmental awareness and knowledge, to acquire a readiness and responsibility to solve environmental problems) are lifelong and hierarchic; sensitivity should be stressed to young people, or at the beginning of the education of those who are older [12]. Traditional thinking in the field of environmental education supposes that increased environmental concern and the associated changes in behaviour will result in increased knowledge. It is also argued that environmental knowledge is interdisciplinary and includes knowledge of the following fields: nature, ecology of the natural environment, human ecology, as well as social science [13]. By developing students' ecological knowledge and awareness of environmental problems, students will become more concerned about the environment [14] and thus motivated to engage in pro-environmental behaviour [15]. Previous studies have shown that, for example, the loss of ecological knowledge is likely to critically threaten the effective conservation of biodiversity (e.g., [16,17]). However, other factors, such as attitudes and sensitivity, affect behaviour, action, and, moreover, participation and the relationship between these variables is complex and still unclear. The purpose of the current study is to examine the relationships between Finnish early-stage university students' environmental sensitivity and their attitudes, awareness and knowledge and actions as precursors to their participation in the promotion of sustainable behaviour. Knowledge of the relationships between these variables further promotes the development of instructional strategies for different university study programs that teach sustainability, which, at all levels of education in Finland, are required by the government.

1.1. Measuring the Relationships between Factors Predicting Sustainable Behaviour

The New Environmental Paradigm (NEP) scale [18] is related to the theory of planned behaviour, the emphasized existence of ecological limits to growth, the importance of maintaining the balance of nature and the rejection of the notion that nature exists primarily for human use. The NEP scale is an instrument designed to motivate respondents to complete it, with 12 items of interest arranged in a familiar Likert-like format that encourages quick responses without excessive reflection or comparison. Many of the environmental education studies that attempt to clarify the complex relationship between variables have used the NEP scale, including by replicating, modifying, or supplementing the scale. The Revised NEP scale is the New Ecological Paradigm scale [19,20]; the NEP scale has been combined with the Dominant Social Paradigm scale [21] and the NEP scale has also been supplemented with qualitative questions [22]. Some researchers treat it as a measure of environmental concerns, values and attitudes or beliefs. Based on the extensive review of the use of the NEP scale, Hawcroft and Milfont [23] suggested that researchers continue to use the NEP scale as a standardized measure of environmental attitude, which is an idea supported by Shephard et al. [24].

The Revised NEP scale [19] comprises 15 items. The items added to the NEP scale focus on the likelihood of the potentially catastrophic environmental changes besetting mankind, as well as on the idea that humans are exempt from the constraints of nature. The terminology was also modified and the "unsure" category was added as a midpoint. Six items were adopted from the original NEP Scale and four were slightly modified. Shephard et al. [24] utilized the Revised NEP scale complemented with questions from different methodological approaches and also added open questions and they noticed that either all the instruments reported the same characteristics or that, on average, varying characteristics co-located within individuals in the student population under

study, which further supports the use of the NEP scale. Harraway et al. [25] also found the scale to be usable and Noblet, Anderson and Teisl [26] further pointed out that whether the NEP scale should be used as a simple construct, multiple constructs, or perhaps both remains an open question.

The Environmental Scale (2-MEV) is based on earlier attitudinal scales for measuring environmental concern and actual behaviour toward the natural environment. It was further developed later to measure two dimensions of environmental perceptions: Preservation of Nature, that is, the intent to preserve the environment (biocentric dimension); and the Utilization of Nature, that is, the usage of the environment (anthropocentric dimension) [27–29]. Bogner and Wiseman [28] presented five primary factors: intent to support, care with resources, enjoyment of nature, human dominance and altering nature; the first three reflected the factor 'preservation' and the last two expressed 'utilization.'

Several tools related to the definition of sustainable development have also been used, including environmental, economic and social dimensions of sustainable development. For example, the tool developed by Michalos et al. [30] to measure students' knowledge, favourable attitudes and favourable behaviours concerning sustainable development comprises 50 items—24, 18 and 17 items for the three aspects, respectively—using the Likert scale. Olsson, Gericke and Chang-Rundgren [31] developed a Likert-scale questionnaire while considering the ecological, economic and social dimensions of sustainable development; the tool was used for the evaluation of sustainability consciousness in terms of sustainability knowingness, attitudes and behaviours.

1.2. Relationships between Factors Predicting Sustainable Behaviour

Bamberg and Möser [32] carried out a meta-analysis and used so-called meta-analytic structural equation modelling (MASEM) to find the relationships between eight determinants of pro-environmental behaviour. Their analysis confirmed that pro-environmental behavioural intention mediates the impact of all other psycho-social variables on pro-environmental behaviour. The first four factors—problem awareness, social norms, internal attribution and a feeling of guilt—modify the next three factors: personal behaviour control, attitude and moral norm, which, in turn, modify the intention to act. The intention to act then modifies behaviour. The complexity of this model demonstrates that knowledge is an important factor for behaviour. The influence of knowledge on behaviour is both complex and indirect and it is necessary to arouse action.

Much research has been carried out to define the relationships between attitudes and behaviour and most researchers do agree that attitudinal change does affect behaviour. A number of researchers have shown that increasing an individual's knowledge results in more positive attitudes toward the environment and more responsible environmental behaviour (e.g., [30,33,34]). However, addressing knowledge is not enough to lead to changes in behaviour; attitude is also important for behaviour [10,35,36]. Esa [34] suggests that even a good knowledge of the environment, coupled with a positive attitude toward it, does not necessarily translate into positive environmental practices.

Recently, Newman and Fernandes [37] confirmed previous research results on pro-environmental behaviour that found relationships between situational factors and environmental attitudes, values and beliefs. Heeren et al. [38] studied the relationship between sustainability knowledge and pro-environmental behaviour (with sustainability also accounting for social issues). Their study revealed that even though knowledge is important, attitude toward behaviour that promotes sustainability, the ability to engage in that behaviour and a perception of what others think about that behaviour are even more important.

Tuncer et al. [39] found that even though pre-service teachers had low levels of environmental knowledge, they expressed positive attitudes toward the environment and a high degree of concern about environmental problems. They argued that environmentally knowledgeable teachers will produce students who are environmentally literate, have positive attitudes toward the environment and also show concern for environmental problems. In their study, pre-service teachers with a slight sense of responsibility toward the environment tended to have positive feelings and values about the environment and they were positively inclined toward environmentally responsible behaviour.

There is a lot of research which implicates childhood experiences or nature experiences as important contributors to people's relationships with and interest in nature today and nature in the future (e.g., [5,40–42]). Outdoor nature experience is generally integrated into education to arouse emotions and thus promote environmental action [43]. Bögeholz [44] also emphasized nature experiences, including negative relationships with nature. Also, for adults, their childhood nature experiences become a part of their interest in learning or curiosity to learn more about nature [40]. In Sweden, schools focusing on education for sustainable development had only a small positive effect on pupils' sustainability consciousness in grade 6; in grade 9, the effect was negative [31]. Based on their findings, they questioned the usefulness of these special schools. Also, in Finland, it is not clear whether nature schools really contribute to environmental awareness and responsibility [12].

Environmental attitude may differ among students from different study programs. Biasutti and Surian [45] found that engineering students possessed a more enhanced pro-sustainability attitude than applied science, health science and social science students. Educational science students seemed to prefer the social dimension over the knowledge and the 'to do' dimensions of sustainability compared to engineering and applied science students, who scored significantly higher on the 'learning to know' and 'learning to do' scales. In their longitudinal analysis, Shephard et al. [46] found differences between students in Zoology and Human Nutrition. Further, Biasutti and Frate [7] found that agriculture students scored better on the environmental factor than did the psychology students, whereas the psychology students scored better on the society factor than did the agriculture students. Agriculture students had a greater pro-environmental attitude, whereas psychology students were more oriented toward social issues. Uitto and Saloranta [47] compared teachers from different disciplines and noticed that every subject's teacher group had its specific strengths and limitations in education for sustainability. For instance, biology and geography, history and social studies, and, to some extent, also religion and ethics teachers considered several but different sustainability dimensions often and used holistic approaches to their sustainability-related teaching [47]. Larson et al. [48] found that, among nature-based recreationists, there was a range of variation and diversity associated with pro-environmental actions.

1.3. The Purpose of the Study

The purpose of this study is to explore the relationships between university students' sensitivity and attitudes toward the environment; awareness of the environment; knowledge of environmental issues, such as ecological issues; pro-environmental actions; and participation. We tested the underlying assumption that—together with sensitivity—attitudes, awareness and knowledge predict the sustainable behaviour of students. If this assumption is true, we would expect that students who are more aware of, sensitive to and knowledgeable about their environment are more likely to engage in more sustainable behaviour. We expect that there are some differences among students from different study programs. We also tested whether broadening the NEP Scale with items concerning sensitivity toward both the natural and social environment could help us to understand the relationships between the variables influencing behaviour.

2. Materials and Methods

Data were collected through a paper questionnaire in the context of university courses. The lecturer responsible for the course delivered the questionnaire to the students and collected their responses. The response rate was high, 90%, even though participation was voluntary. The questionnaire comprised five parts (A–E) and included a total of 73 items or questions.

Development of the questionnaire began with a review of the relevant literature, from which we yielded four dimensions defining education for sustainable development. The questionnaire was based on the dimensions of environmental education [3,4]. Part A constituted 29 items on awareness, sensitivity and attitudes toward both the physical and social environment: for example, 'I like to be in the forest,' 'For me landscapes are insignificant,' 'My favourite landscape is the view of the town,' 'I remember the

buildings in the area where I live' and 'I enjoy working in a group' (cf. [5,40–42,44]). In predicting whether an individual engages in sustainable behaviour, attitudes about specific behaviours are more predictable than attitudes about the environment or sustainability in general [38]. As such, the statements in Part A were created to relate to Finnish culture and are seen as being significant for identifying sensitivity as a starting point in the education for sustainable development. The items concerning enjoyment and sensitivity were created for this questionnaire for validation and were based on discussions with two experts in environmental education. In the pilot stage, natural environment items focused on forests but, after a pilot study [49], items concerning fields were added.

Part B included 15 items related to science/ecology and considered natural processes and values, such as 'Humans must live in harmony with nature,' 'Plants and animals exist primarily for human use' and 'I don't intend to do anything for the benefit of ecology because it is the job of the government.' Part C presented 13 statements that concerned knowledge of the environment: 'Greenhouse effect is bad for our environment,' 'Biodiversity is a prerequisite for the continuity of life' and 'Decomposers are a part of the ecosystem.' Some of the items in Parts B and C were adopted from the modified NEP/DSP Environmental Attitudes Scale [21]. Students were asked to rate items in Parts A–C according to the 5-point Likert-scale.

Part D (10 statements) concerned everyday activities—in particular, how personal sacrifices are made in favour of the environment and wildlife: 'Where I live, I sort my garbage; use recycling products and so on.' In Part D, the self-report response options ranged from '1 = always,' 'occasionally´ to '3 = never.' Part E was concerned with, for example, definitions of the terms 'environmental education' and 'education for sustainability'; also, it included students' perceptions of the contribution of their university to 'Education for sustainable development.'

Structural equation modelling was used because it allows for combining confirmatory factor analysis (CFA) and regression analysis in the same model in order to test and analyse relationships among latent constructs and their measured variables [50]. In this study, we used confirmatory factor analysis to investigate the structure of data of the parts A, B and C. From the 57 measured variables, only 17 could be included into model after using an alternative model approach (several models were tested). In the final model, only the items with reasonable high loadings were included in the model, in order to reach acceptable construct reliabilities and variance explained by the constructs. As a result, the model shown in Figure 1 was developed using Amos version 21.0 (Amos Development Corporation, Wexford, PA, USA) and SPSS software version 23 (IBM Corp, Armonk, NY, USA).

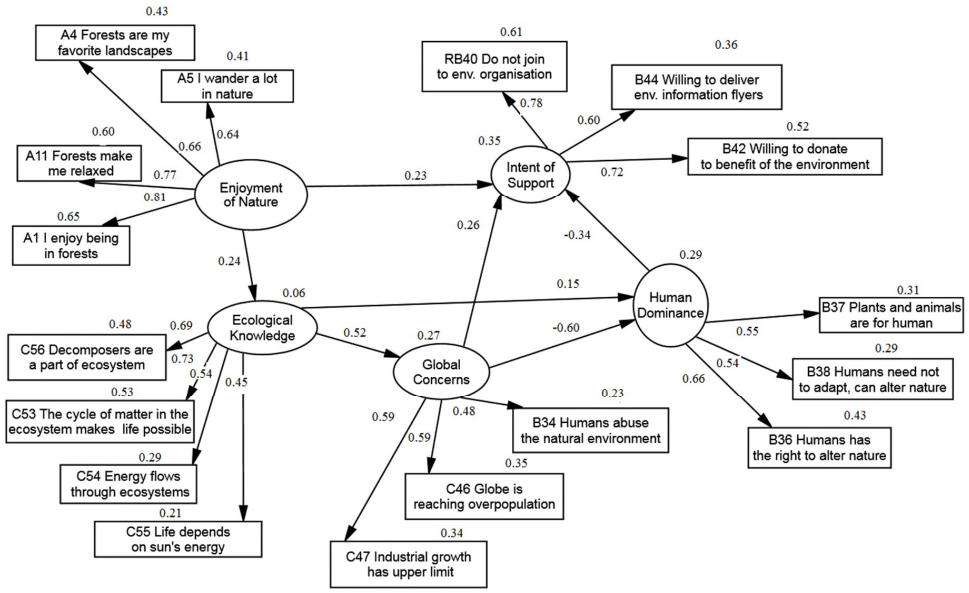

Figure 1. The structural equation model of environmental knowledge and perceptions (with standardized estimates, all values below 1).

2.1. Demographics

The participants in the study comprised 674 university students from two universities and from different disciplines: educational sciences (n = 325; 49%), engineering (n = 139; 21%), mathematics and science (n = 110; 17%) and humanistic disciplines (n = 85; 13%) (15 students did not report their discipline). With the exception of engineering students, all students came from the same university. Because this university does not have an engineering program, engineering students from another university were invited to participate. All universities in Finland are expected to educate students on sustainable development. The distribution among the participants were: females (66%) and males (34%); first-year students (66%), second-year students (12%), third-year students (13%) and fourth-year students (5%).

2.2. Instrument Validation

The goodness-of-fit of the measurement model (Appendix A) was assessed with several indicators of fit (Table 1). The chi-square statistic is considered too restrictive an indicator of the model's goodness-of-fit, too often rejecting models with sample sizes above 250 [51]. From the indicators of fit (Table 1), the normed fit index with NFI = 0.935 is somewhat lower than the recommended lower limit of 0.95 for a good model fit, as recommended by Hu and Bentler [52]. Instead, the comparative fit index (CFI) and Tucker-Lewis Index (TLI) were used, with CFI = 0.974 and TLI = 0.963, well above the suggested lower limit of 0.95 for a good fit [51,52]. Also applied was the root mean square error of approximation (RMSEA) with RMSEA = 0.030, with a 90% confidence interval; this is below the recommended upper limit of 0.05 for a good fit [51]. Based on these indices of fit, we concluded that the CFA model has a reasonably good fit. Also, the estimated significant loadings provide evidence of convergent validity and the unidimensionality of the constructs [53].

Table 1. The measurement model's goodness-of-fit (n = 674).

	Chi-Square (df)	P	CMIN/DF	NFI	CFI	TLI	RMSEA [conf90]
Estimate	175.256 (109)	0.00	1.608	0.935	0.974	0.963	0.030 [0.022;0.038]

Note: CMIN/DF = Chi-square divided by degrees of freedom; NFI = normed fit index; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSE = root mean square error of approximation [with 90% confidence interval].

Discriminant validity was checked by comparing the average variance extracted against the squared construct correlations [54]. Table 2 shows that the squared correlations between constructs were smaller than the corresponding average variance extracted, indicating that these latent constructs were discrete.

Table 2. Discriminant validity of the constructs.

	CR	AVE	Global Concerns	Enjoyment of Nature	Intent of Support	Ecological Knowledge	Human Dominance
Global Concerns	0.572	0.310	0.310				
Enjoyment of Nature	0.814	0.524	0.030	0.524			
Intent of Support	0.749	0.501	0.203	0.112	0.501		
Ecological Knowledge	0.700	0.376	0.255	0.052	0.073	0.376	
Human Dominance	0.608	0.343	0.271	0.076	0.279	0.018	0.343

Note: CR = construct reliability, AVE = average variance extracted. Diagonals represent the average variance extracted and entries under the diagonals represent the squared construct correlations.

The five-construct measurement model with 17 measured items was considered to be acceptable, even though the loadings of some of the measured variables were just above the recommended lower limit (0.4) but less than the recommended value (0.7) for a good fit [55]. By accepting lower loadings for measured variables, the average variance extracted (Table 2) from some constructs was somewhat

less than the recommended 0.50 (as shown by the diagonals in Table 2). Lower loadings also affected the construct reliabilities, which ranged from 0.572 to 0.814. Yet, in the case of exploratory analysis, these should be 0.60–0.70 [55]; still, Fornell and Larcker [54] consider construct reliability above 0.58 to be acceptable. Altogether, with these considerations, the instrument was determined (with precautions) to be acceptable for measuring and reporting and, furthermore, for developing the path model for evaluating the relationships between constructs.

3. Results

3.1. University Students' Environmental Attitudes, Knowledge and Intent to Support

Generally (see Table 3), the construct with the most agreement (M = 1.57) consisted of items related to 'Ecological Knowledge'; with almost equal agreement was 'Enjoyment of Nature' (M = 1.96) and 'Global Concerns' (M = 1.84). The construct with the most disagreement was 'Human Dominance' (M = 3.74) and, interestingly, with almost similar disagreement, 'Intent of Support' environmental activities (M = 3.60).

Table 3. Environmental attitudes, knowledge and intent to support (scale 1 = totally agree, 5 = totally disagree).

Construct	Mean (M)	Standard Deviation
Enjoyment of Nature (4 items) A4. The forest is one of my favourite landscapes. A5. I move around a lot in nature. A11. It is relaxing to be in a forest. A1. I like to be in the forest.	1.96	0.756
Ecological Knowledge (4 items) C56. Decomposers are a part of the ecosystem. C53. The cycle of matter in the ecosystem makes life possible. C54. Energy flows through the ecosystem. C55. Life is dependent on the Sun's energy.	1.57	0.603
Global Concerns (3 items) C47. There is a limit to the extent to which our industrialized society can expand. C46. The number of people the Earth can support is reaching its maximum. B34. Humans severely abuse the environment.	1.84	0.635
Human Dominance (3 items) B36. Humans have the right to modify the natural environment to suit their own needs. B38. Humans need not to adapt to the natural environment because they can shape it to suit their own needs. B37. Plants and animals exist primarily for human use.	3.74	0.747
Intent of Support (3 items) (Reversed) B40. I do not think I would join any organization concerned solely with environmental issues. B44. I would be prepared to go from house to house to distribute literature on the environment. B42. I would like to donate some of my money to improve the environment.	3.60	0.919

3.2. The Relationship of Students' Environmental Attitudes, Knowledge and Intent of Support

Structural equation modelling produced a path model (Figure 1). The goodness-of-fit indices were CFI = 0.966 and TLI = 0.954, above the suggested lower limit of 0.95 [50,51]. The root mean square error of approximation, RMSEA = 0.034, is below the recommended upper limit of 0.05, also indicating

a good fit [51]. Based on these considerations, we conclude that the path model has a reasonably good fit (Table 4).

Table 4. The path model's goodness-of-fit (n = 674).

	Chi-Square (df)	P	CMIN/DF	NFI	CFI	TLI	RMSEA [conf90]
Estimate	197.781 (112)	0.00	1.766	0.926	0.966	0.954	0.034 [0.026;0.041]

Note: NFI = normed fit index; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSE = root mean square error of approximation [with 90% confidence interval].

There were positive relations (see Table 5) from 'Enjoyment of Nature' to 'Intent of Support' environmental activities (β = 0.23) and from 'Enjoyment of Nature' to 'Ecological Knowledge' (β = 0.24). There was also a strong (β = 0.52) positive relation from 'Ecological Knowledge' to 'Global Concerns' and a weak (β = 0.15; p = 0.057) positive relationship from 'Ecological knowledge' to 'Human Dominance' (meaning that agreeing with 'Ecological Knowledge' is associated with agreeing with 'Human Dominance'). There was a strong negative relation (β = −0.60) from 'Global Concerns' to 'Human Dominance' and a positive relation from 'Global Concerns' to 'Intent of Support' (β = 0.26). There was also a negative relation from 'Human Dominance' to 'Intent of to Support' (β = −0.34).

Table 5. Regression weights of the relations between constructs.

Relation			Standardized Estimate (β)	Estimate	S.E.	p
Ecological Knowledge	<—	Enjoyment of Nature	0.236	0.129	0.028	<0.001
Global Concerns	<—	Ecological Knowledge	0.518	0.798	0.106	<0.001
Human Dominance	<—	Global Concerns	−0.597	−0.766	0.131	<0.001
Human Dominance	<—	Ecological Knowledge	0.151	0.299	0.157	0.057
Intent of Support	<—	Global Concerns	0.257	0.482	0.133	<0.001
Intent of Support	<—	Human Dominance	−0.344	−0.502	0.107	<0.001
Intent of Support	<—	Enjoyment of Nature	0.232	0.366	0.072	<0.001

Note: <— arrow points direction of the relation.

3.3. Environmental Friendliness in Daily Activities

The questionnaire had 10 items concerning environmentally friendly actions during daily activities. K-means cluster analysis was carried out in order to group the cases and was based on the items concerning environmentally friendly actions during daily activities. The analysis yielded three separate groups (Table 6): "Occasional actors" (n = 206; 31%), "Sorters" (n = 175; 27%) and "Resource savers" (n = 276; 42%). The "Occasional actors" 'occasionally' responded to all statements regarding daily activities, whereas the "Sorters" responded to nearly all statements 'occasionally,' with the exception being their response of 'always' to 'I tend to sort wastes'. The "Resource savers" responded to all statements systematically with the value indicating 'almost always.'

Table 6. K-means cluster analysis grouping of the cases (n = 657; scale 1 = always, 2 = occasionally, 3 = never).

Where I live, I	"Occasional Actors" (n = 206) Mean	"Sorters" (n = 175) Mean	"Resource Savers" (n = 276) Mean
D60. attempt to save energy	1.90	1.74	1.13
D65. try to save water	2.03	2.04	1.13
D66. use goods as long as they last	1.53	1.39	1.18
D58. sort my garbage	2.11	1.02	1.30
D64. avoid disposable products	1.98	1.74	1.35
D59. use recycling products	2.07	1.98	1.77
D67. repair my things or get them repaired	1.81	1.63	1.36
D62. do not buy food which is in plastic containers or polystyrene packages	2.17	2.09	2.05
D63. buy naturally produced goods	2.16	2.06	1.97
D61. travel by car/motorbike when I could walk or cycle	2.22	2.31	2.38

3.4. The Groups' Differences in Knowledge, Attitudes and Intent to Support

The association between daily actions (membership of the clustered groups above) and the mean score constructs of university students' environmental attitudes and intent to support was first investigated using analysis of variance (Table 7). There were statistically significant differences in almost all constructs among the groups. Except for the construct 'Ecological Knowledge,' the difference between the "Occasional actors." "Sorters" and "Resource savers" was only nearly significant (F (2.654) = 2.354, p = 0.096). All groups agreed, in different ways, with the constructs 'Intent to Support' and 'Enjoyment of Nature' (results of post hoc analyses using Bonferroni correction are indicated in Table 7, marked with different subscripts). Concerning the construct 'Enjoyment of Nature,' "Resource savers" were in the most agreement, the "Sorters" were in the second most agreement and the "Occasional actors" were in the least agreement. Concerning the construct 'Intent of Support,' the "Resource savers" disagreed the least, the "Sorters" disagreed second least and the "Occasional actors" disagreed the most. "Resource savers" disagreed the most with 'Human Dominance,' whereas "Occasional actors" disagreed the least. In relation to 'Global Concerns,' the group "Resource savers" was more in agreement than the "Sorters" and "Occasional actors."

Table 7. Comparison of the clustered groups to university students' environmental attitudes and intent of support.

	Occasional Actors	Sorters	Resource Savers	F (2.654)	p
	Mean	Mean	Mean		
Intent of Support	3.99 $_{a}$	3.71 $_{b}$	3.25 $_{c}$	44.869	0.000
Human Dominance	3.58 $_{a}$	3.70 $_{a,b}$	3.87 $_{b}$	9.344	0.000
Global Concerns	1.92 $_{a}$	1.92 $_{a}$	1.73 $_{b}$	7.698	0.000
Ecological Knowledge	1.63 $_{a}$	1.59 $_{a}$	1.51 $_{a}$	2.354	0.096
Enjoyment of Nature	2.17 $_{a}$	1.98 $_{b}$	1.78 $_{c}$	16.882	0.000

Note: Values not sharing the same subscript are significantly different pairwise at $p < 0.05$ using Bonferroni correction e.g., at first line all groups differ.

3.5. Students from Different Study Programs

The association between the students from different disciplines and environmental attitudes and intent to support was investigated with analysis of variance. There were statistically significant differences in all constructs among the groups (Table 8). The groups (dis)agreed, in different ways and with a large effect size (η^2 = 0.133), with the construct 'Intent of Support.' For the other constructs, there were some significant differences, yet with small effect sizes (ranging from a small (0.023) to

intermediate (0.041) effect size). The humanistic discipline students were the only group that slightly agreed with 'Intent to Support,' whereas the other groups disagreed (post hoc analyses using Bonferroni correction in Table 8, marked with different subscripts) with 'Intent of Support.' The engineering students were the most disagreeing group. To the contrary, the engineering students disagreed least about 'Human Dominance,' whereas the other student groups—humanistic, educational and natural science discipline students—disagreed similarly but slightly more than engineering students. For 'Global Concerns,' humanistic discipline students agreed the most, although the difference was not significant compared to the natural science students, the difference was significant compared to educational science and engineering students. Concerning the construct 'Ecological knowledge,' the educational science students were the ones to agree the least and the other groups somewhat agreed similarly with the construct. The engineering students agreed least with 'Enjoyment of Nature,' while the educational science students' ratings of the constructs were not significantly different. The humanistic discipline and the natural science students agreed the most with the construct 'Enjoyment of Nature,' which measures the sensitivity toward the environment.

Table 8. Comparison of means between students from different disciplines.

	Humanistic (n = 85)	Educational Science (n = 325)	Natural Science (n = 110)	Engineering (n = 137)	F	Sig.	eta
	Mean	Mean	Mean	Mean			
Intent of Support	2.87 $_{a}$	3.62 $_{b}$	3.55 $_{b}$	4.06 $_{c}$	33.391	0.000	0.133
Human Dominance	3.92 $_{a}$	3.79 $_{a}$	3.78 $_{a}$	3.51 $_{b}$	6.780	0.000	0.030
Global Concerns	1.58 $_{a}$	1.90 $_{b,c}$	1.74 $_{a,b}$	1.96 $_{c}$	8.565	0.000	0.038
Ecological Knowledge	1.39 $_{a}$	1.69 $_{b}$	1.46 $_{a}$	1.48 $_{a}$	9.279	0.000	0.041
Enjoyment of Nature	1.76 $_{a}$	1.95 $_{a,b}$	1.85 $_{a}$	2.12 $_{b}$	5.106	0.002	0.023

Note: Values in the same row and sub-table not sharing the same subscript are significantly different at $p < 0.05$ in the two-sided test of equality for the column means e.g., in first row humanistic and educational science differ but educational science and natural science do not. Tests are adjusted for all pairwise comparisons within the row of each innermost sub-table using Bonferroni correction.

When comparing the students from different disciplines to the members in the clusters based on daily activities (cf. Table 6), the students from the humanistic disciplines belonged to "Resource savers" (64%) more often than did students from other disciplines (around 40%). The educational science students (35%) and the engineering students (37%) were "Occasional actors" more often than were humanistic discipline (13%) or natural science students (26%). The natural science students belonged to "Sorters" (34%) more often than the other discipline students (around 24%). The differences between these groups were statistically significant (χ^2 = 26.696, df = 6, $p < 0.001$).

4. Discussion

University students' environmental sensitivity and attitudes, knowledge and intent to act [3] were measured by a scale that was created based partly on the NEP/DSP Scale [18–21,23–26,32]. The scale was supplemented with new items regarding sensitivity, attitudes and feelings toward the environment. The instrument provides measures for the constructs 'Enjoyment of Nature,' 'Ecological Knowledge,' 'Global Concerns,' 'Human Dominance' and 'Intent of Support' [27–29].

Among the sample of students, 'Enjoyment of Nature' related positively to the 'Intent to Support' environmental activities. University students' enjoyment of the natural environment, particularly forests, predicted, through intention, pro-environmental behaviour, in agreement with prior studies that have indicated that behaviour follows intention [3,8]. This finding is in line with that of Bögeholz [44], who stated that outdoor nature experience (forest experiences) is generally integrated in education to consider emotions and thus to promote environmental action, which, however, was not seen in the studies of Olsson et al. [31] and Jeronen et al. [12].

There was also a positive relation from 'Enjoyment of Nature' to 'Ecological Knowledge.' This suggests that university students who enjoy nature understand ecology. As prior research has shown, knowledge is necessary for pro-environmental actions [15,34–36]. Our results indicate that the effect of enjoyment toward pro-environmental actions also comes through knowledge, although we cannot confirm the finding that knowledge relates to enjoyment (cf. [3,33,39]).

We also found that students' 'Ecological knowledge' had a positive relation to 'Global concerns,' which supports the finding of Tuncer et al. [39]. Students who possessed ecological knowledge perceived the dominance of humans over nature, although the relation was weak. Students who possessed 'Global concerns' were less likely to accept 'Human dominance' and furthermore 'Global concerns' were related to 'Intent of support' environmental activities. Students who agreed on 'Human dominance' over nature did not possess any 'Intent of support' pro-environmental behaviour.

Awareness of the environment, represented by 'Enjoyment of Nature,' related to pro-environmental behaviour through direct relation intention (cf. [37]). However, awareness was associated with intention and, through several connections, finally to behaviour; the relationship is complex. Our instrument also included items concerning the social environment; however, our results only revealed the effect of enjoyment of the natural environment on knowledge, concerns and intentions. The findings of Heeren et al. [38] concerning the relationship of sustainability knowledge to pro-environmental behaviour could not be confirmed from the part on social sustainability.

Among the university students, there were three different groups found by cluster analysis concerning environmentally friendly actions during daily activities. These groups differenced most in their 'Enjoyment of nature' and 'Intent of support.' The largest group "Resource savers" (42%) consisted of students who reported saving resources in their daily activities. Among these students, 'Enjoyment of nature' as well as 'Global concerns' was agreed most furthermore the 'Intent of support' environmental activities was highest. The second group was "Occasional actors" (31%), whose 'Enjoyment of nature' and knowledge were at the opposite end to the "Resource savers" (see Table 7) and they disagreed the most with 'Intent of support' environmental activities. The smallest group (27%) was "Sorters." This group was very similar to "Occasional actors" in their daily activities, except for sorting waste. Yet, concerning their 'Enjoyment of nature' and 'Intent of support' they reported agreeing slightly more than "Occasional actors."

The Humanistic discipline students were slightly more eager to participate in actions that support the environment than the other groups. The humanistic discipline and the natural science students enjoyed nature the most: they were sensitive toward the environment. The students from the humanistic disciplines belonged to "Resource savers" (64%) more often than other disciplines (around 40%). Humanistic discipline students were the group most concerned about the Earth's future and their knowledge of ecology was similar to that of natural science and engineering students, yet better than educational science students' knowledge. The engineering students held only slightly the opinion that humans should not dominate the environment and they agreed the least and similarly to educational science students, with items related to global concerns (e.g., overpopulation and industrial growth). The engineering students were less eager to participate in actions to support the environment than the other groups. The engineering students least enjoyed nature, yet the educational science students reported their enjoyment of nature almost as rarely. For daily actions, the educational science students (35%) and the engineering students (37%) were "Occasional actors" more often than humanistic discipline (13%) or natural science students (26%). The natural science students belonged to the "Sorters" group (34%) more often than the other discipline students (around 24%). Overall, there were slight differences among the university students' perceptions based on the university or study programs, as was found in previous research [7,45,46,48].

One limitation of this study is the use of self-reported behavioural measures (daily activities), instead of observed behaviour (see [4]). Another limitation is that the knowledge, both ecological and global, was also based on self-evaluation. Although the data were collected with convenience sampling and not as a random sample, it was collected from two different universities and from

different disciplines. The instrument was adapted to a local, national context but, at the same time, the global aspect was raised and connections between the two were established.

5. Conclusions

In education for sustainability, a more complete comprehension of the relationship between sensitivity, attitudes, awareness, knowledge and behaviour may better direct educational efforts. Compared to prior research, due to the additional items concerning sensitivity and awareness in our instrument, we were able to uncover the importance of sensitivity to the enjoyment of nature using a complex model of relationships between awareness, attitudes, knowledge, concerns and intentions. Sensitivity and awareness toward nature is the basis for the enjoyment of nature. This "Enjoyment of nature" was directly positively related to the intention of support pro-environmental activity and knowledge. Furthermore, it had a mediational effect on knowledge, concern and the belief of human dominance over nature. There are various ways to mediate among student groups. Understanding the extent to which different variables influence university students' behaviour could help direct sustainability and science education curricula to focus on specific areas of education (regarding lifestyle or living) that are relevant to the attitudes that influence sustainable behaviour.

Recognition of the contrasting profiled "groups" could help to better focus on the efforts needed, especially when considering the ecological aspect of sustainability. This study emphasizes the role of global aspects. These aspects seem to suggest that global concern and its relation to ecological knowledge is the key combination that will lead to pro-environmental active citizenship. In this study, most of the students in humanistic disciplines (64%) belonged to the group of resource savers, whose global concerns were highest. Also, ecological knowledge explained a lot of the variation in global concerns (R^2 = 0.27). Unfortunately, more than half of the university students were not resource savers, and, in their daily activities, they reported only occasional consideration of saving natural resources and they disagreed more with the intention of support pro-environmental behaviour. This suggests that even scientific ecological knowledge is not enough to advance pro-environmental attitudes unless it is very strongly related to global concerns. This reflects the need for educators to emphasize global issues during their lessons. Unfortunately, the educational science students had the weakest ecological knowledge and they were occasional actors in their daily activities. This presents a challenge to educational science educators (e.g., in teacher education) to advance the development of both ecological knowledge and global issues. The engineering students were the group that had no intention to support pro-environmental activities and, while they had ecological knowledge, their level of global concern was among the weakest. Again, this exposes the need for engineering education to emphasize global issues in their education.

The instrument used in this study was administered once amongst mostly first-year students. In the future, it could be interesting to follow the potential development of university students' environmental knowledge, attitudes and pro-environmental actions. The study of personal activities—here, daily activities—could benefit from expansion of the instrument to include a 5-point scale (e.g., 1 = daily, 2 = weekly, 3 = monthly, 4 = few times a year, 5 = never). This would allow for the inclusion of this construct in an enhanced model.

Author Contributions: The authors contributed to several stages of the research differently. The main responsibilities were: S.K. and T.K. planned the questionnaire and collected the data, J.K. analysed the data; J.K., S.K. and T.K. contributed to writing the article.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Measurement Model: CFA-Model; Standardized Estimates, Error Terms Omitted

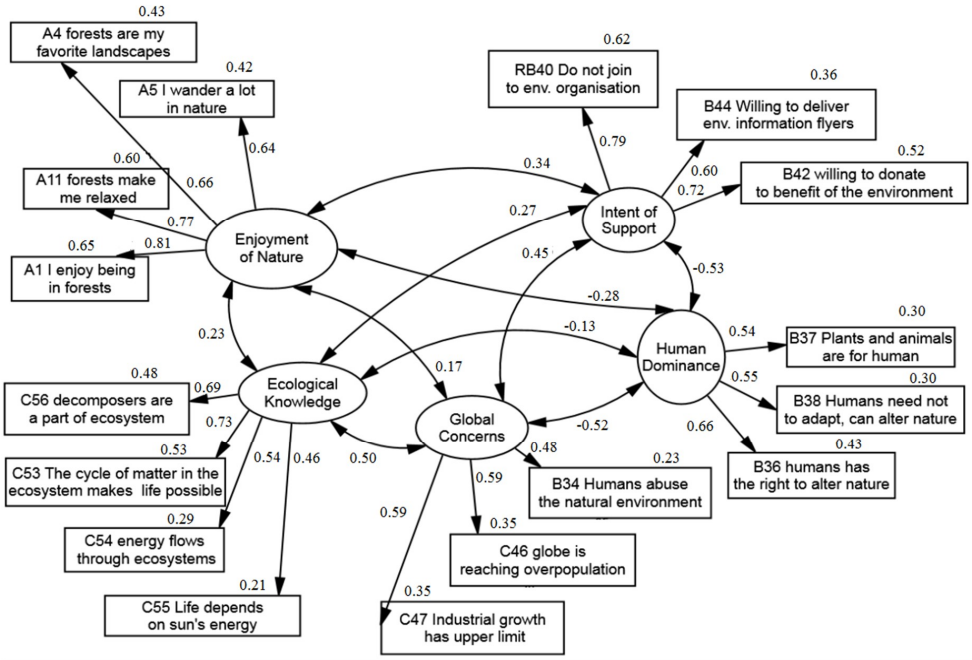

Figure A1. Measurement Model: CFA-Model; Standardized Estimates, Error Terms Omitted. (note: all standardized values in this figure are below 1).

References

1. Jacobson, M.J.; Markauskaite, L.; Portolese, A.; Kapur, M.; Lai, P.L.; Roberts, G. Designs for learning about climate change as a complex system. *Learn. Instr.* **2017**, *52*, 1–14. [CrossRef]
2. Kukkonen, J.E.; Kärkkäinen, S.; Dillon, P.; Keinonen, T. The Effects of Scaffolded Simulation-Based Inquiry Learning on Fifth Graders' Representations of the Greenhouse Effect. *IJSE* **2013**, *36*, 406–424. [CrossRef]
3. Hungerford, H.R.; Volk, T.L. Changing Learner Behavior through Environmental Education. *J. Environ. Educ.* **1990**, *21*, 8–21. [CrossRef]
4. Jeronen, E.; Kaikkonen, M. Thoughts of Children and Adults about the Environment and Environmental Education. *Int. Res. Geogr. Environ. Educ.* **2002**, *11*, 341–363. [CrossRef]
5. Braun, T.; Dierkes, P. Connecting students to nature—How intensity of nature experience and student age influence the success of outdoor education programs. *Environ. Educ. Res.* **2017**, *23*, 937–949. [CrossRef]
6. Can, Ö.K.; Lane, J.F.; Ateskan, A. Facilitating place-based environmental education through bird studies: An action research investigation. *Environ. Educ. Res.* **2017**, *23*, 733–747. [CrossRef]
7. Biasutti, M.; Frate, S. A validity and reliability study of the Attitudes toward Sustainable Development scale. *Environ. Educ. Res.* **2017**, *23*, 214–230. [CrossRef]
8. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Dec. Process.* **1991**, *50*, 179–211. [CrossRef]
9. Ajzen, I. The Theory of Planned Behavior. In *Handbook of Theories of Social Psychology*; Van Lange, P.A.M., Kruglanski, A.W., Higgins, E.T., Eds.; Sage: London, UK, 2011; pp. 438–459.
10. Ajzen, I.; Joyce, N.; Sheikh, S.; Cote, N. Knowledge and the prediction behavior: The role of information accuracy in the theory of planned behavior. *Basic Appl. Soc. Psychol.* **2011**, *33*, 101–117. [CrossRef]
11. Hines, J.; Hungerford, H.; Tomera, A. Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *J. Environ. Educ.* **1987**, *18*, 1–8. [CrossRef]
12. Jeronen, E.; Jeronen, J.; Raustia, H. Environmental Education in Finland—A Case Study of Environmental Education in Nature Schools. *IJESE* **2009**, *4*, 1–23.
13. Pérez-Belis, V.; Bovea, M.D.; Ibáñez-Forés, V. An in-depth literature review of the waste electrical and electronic equipment context: Trends and evolution. *WM&R* **2015**, *33*, 3–29. [CrossRef]

14. Palmberg, I.; Berg, I.; Jeronen, E.; Kärkkäinen, S.; Norrgård-Sillanpää, P.; Persson, C.; Vilkonis, R.; Yli-Panula, E. Nordic-Baltic student teachers' identification and interest in plant and animal species: The importance of species identification and biodiversity for sustainable development. *JSTE* **2015**, *26*, 549–571. [CrossRef]
15. Kim, G.W.; Vaswani, R.T.; Kang, W.; Nam, M.; Lee, D. Enhancing Ecoliteracy through Traditional Ecological Knowledge in Proverbs. *Sustainability* **2017**, *9*, 1182. [CrossRef]
16. Aswani, S.; Lemahieu, A.; Sauer, W.H.H. Global trends of local ecological knowledge and future implications. *PLoS ONE* **2018**, *13*, e1095440. [CrossRef] [PubMed]
17. Joa, B.; Winkel, G.; Primmer, E. The unknown—A review of local ecological knowledge in relation to forest biodiversity conservation. *Land Use Policy* **2018**, *79*, 520–530. [CrossRef]
18. Dunlap, R.E.; Van Liere, K.D. The "new environmental paradigm": A proposed measuring instrument and preliminary results. *J. Environ. Educ.* **1978**, *9*, 10–19. [CrossRef]
19. Dunlap, R.E.; Van Liere, K.D.; Mertig, A.G.; Jones, R.E. Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *JSI* **2000**, *56*, 425–442. [CrossRef]
20. Dunlap, R.E. The New Environmental Paradigm Scale: From Marginality to Worldwide Use. *J. Environ. Educ.* **2008**, *40*, 3–18. [CrossRef]
21. La Trobe, H.L.; Acott, T.G. A Modified NEP/DSP Environmental Attitudes Scale. *J. Environ. Educ.* **2000**, *32*, 12–20. [CrossRef]
22. Lalonde, R.; Jackson, E.L. The New Environmental Paradigm Scale: Has It Outlived Its Usefulness? *J. Environ. Educ.* **2002**, *33*, 28–36. [CrossRef]
23. Hawcroft, L.J.; Milfont, T.L. The use (and abuse) of the new environmental paradigm scale over the past 30 years: A meta-analysis. *J. Environ. Psychol.* **2010**, *30*, 143–158. [CrossRef]
24. Shephard, K.; Smith, N.; Deaker, L.; Harraway, J.; Broughton-Ansin, F.; Mann, S. Comparing different measures of affective attributes relating to sustainability. *Environ. Educ. Res.* **2011**, *17*, 329–340. [CrossRef]
25. Harraway, J.; Broughton-Ansin, F.; Deaker, L.; Jowett, T.; Shephard, K. Exploring the use of the revised new ecological paradigm scale (NEP) to monitor the development of students' ecological worldviews. *J. Environ. Educ.* **2012**, *43*, 177–191. [CrossRef]
26. Noblet, C.L.; Anderson, M.; Teisl, M.F. An empirical test of anchoring the NEP scale in environmental ethics. *Environ. Educ. Res.* **2013**, *19*, 540–551. [CrossRef]
27. Bogner, F.X.; Wilhelm, M.G. Environmental perspectives of pupils: The development of an attitude and behaviour scale. *Environmentalist* **1996**, *16*, 95–110. [CrossRef]
28. Bogner, F.X.; Wiseman, M. Toward Measuring Adolescents Environmental Perception. *Eur. Psychol.* **1999**, *4*, 139–151. [CrossRef]
29. Schneller, A.J.; Johnson, B.; Bogner, F.X. Measuring children's environmental attitudes and values in northwest Mexico: Validating a modified version of measures to test the Model of Ecological Values (2-MEV). *Environ. Educ. Res.* **2015**, *21*, 61–75. [CrossRef]
30. Michalos, A.C.; Creech, H.; Swayze, N.; Kahlke, P.M.; Buckler, C.; Rempel, K. Measuring Knowledge, Attitudes and Behaviours Concerning Sustainable Development among Tenth Grade Students in Manitoba. *Soc. Ind. Res.* **2012**, *106*, 213–238. [CrossRef]
31. Olsson, D.; Gericke, N.; Chang-Rundgren, S.-N. The effect of implementation of education for sustainable development in Swedish compulsory schools—Assessing pupils' sustainability consciousness. *Environ. Educ. Res.* **2016**, *22*, 176–202. [CrossRef]
32. 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]
33. Bradley, J.; 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]
34. Esa, N. Environmental knowledge, attitude and practices of student teachers. *Int. Res. Geogr. Environ. Educ.* **2010**, *19*, 39–50. [CrossRef]
35. Johnson, B.; Manoli, C.C. Using Bogner and Wiseman's Model of Ecological Values to measure the impact of an earth education on children's environmental perceptions. *Environ. Educ. Res.* **2008**, *14*, 115–127. [CrossRef]
36. Robelia, B.; Murphy, T. What do people know about key environmental issues? A review of environmental knowledge surveys. *Environ. Educ. Res.* **2012**, *18*, 299–321. [CrossRef]

37. Newman, T.P.; Fernandes, R. A re-assessment of factors associated with environmental concern and behaviour using the 2010 General Social Survey. *Environ. Educ. Res.* **2016**, *22*, 153–175. [CrossRef]
38. 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. *IJSHE* **2016**, *17*, 613–632. [CrossRef]
39. Tuncer, G.; Tekkaya, C.; Sungur, S.; Cakiroglu, J.; Ertepinar, H.; Kaplowitz, M. Assessing pre-service teachers' environmental literacy in Turkey as a mean to develop teacher education programs. *Int. J. Educ. Dev.* **2009**, *29*, 426–436. [CrossRef]
40. Beery, T.; Jørgensen, K.A. Children in nature: Sensory engagement and the experience of biodiversity. *Environ. Educ. Res.* **2016**, *24*, 13–25. [CrossRef]
41. Brody, M. Learning in nature. *Environ. Educ. Res.* **2005**, *11*, 603–621. [CrossRef]
42. Cheng, J.C.-H.; Monroe, M.C. Connection to Nature Children's Affective Attitude Toward Nature. *Environ. Behav.* **2012**, *44*, 31–49. [CrossRef]
43. Bogner, F.X. The influence of short-term outdoor ecology education on long-term variables of environmental perspective. *J. Environ. Educ.* **1998**, *29*, 17–29. [CrossRef]
44. Bögeholz, S. Nature experience and its importance for environmental knowledge, values and action: Recent German empirical contributions. *Environ. Educ. Res.* **2006**, *12*, 65–84. [CrossRef]
45. Biasutti, M.; Surian, A. The students' survey of education for sustainable development competencies: A comparison among faculties. *Discourse Commun. Sustain. Educ.* **2012**, *3*, 75–82. [CrossRef]
46. Shephard, K.; Harraway, J.; Jowett, T.; Lovelock, B.; Skeaff, S.; Slooten, L.; Strack, M.; Furnari, M. Longitudinal analysis of the environmental attitudes of university students. *Environ. Educ. Res.* **2015**, *21*, 805–820. [CrossRef]
47. Uitto, A.; Saloranta, S. Subject Teachers as Educators for Sustainability: A Survey Study. *Educ. Sci.* **2017**, *7*, 8. [CrossRef]
48. Larson, L.R.; Stedman, R.C.; Cooper, C.B.; Decker, D.J. Understanding the multi-dimensional structure of pro-environmental behavior. *J. Environ. Psychol.* **2015**, *43*, 112–124. [CrossRef]
49. Kärkkäinen, S.; Kukkonen, J.; Keinonen, T. University students and global responsibility. In *Forum on Global Responsibility in Research and Education: Practices in Partnerships and Daily Activities*; Tapola, H., Suntioinen, S., Karjalainen, K., Eds.; University of Eastern Finland: Kuopio, Finland, 2010; pp. 28–34.
50. Reisinger, Y.; Mavondo, F. Structural Equation Modeling. *JTTM* **2007**, *21*, 41–71. [CrossRef]
51. Byrne, B.M. *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*; Lawrence Erlbaum Associates Publishers: Mahwah, NJ, USA, 2001; pp. 24–45.
52. Hu, L.; Bentler, P. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model.* **1999**, *6*, 1–55. [CrossRef]
53. Gerbing, D.W.; Anderson, J.C. An updated paradigm for scale development incorporating unidimensionality and its assessment. *JMR* **1988**, *25*, 186–192. [CrossRef]
54. Fornell, C.; Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *JMR* **1981**, *18*, 39–50. [CrossRef]
55. Hair, J.F.; Ringle, C.M.; Sarstedt, M. PLS-SEM: Indeed a silver bullet. *JMTP* **2011**, *19*, 139–152. [CrossRef]