



Brief Report

A Longitudinal Investigation of a Partial SMEC in a Sample of University Students

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Abstract: A part of the Simple Model of Environmental Citizenship (SMEC) was explored in a two-wave longitudinal study in a non-intervention setting with approximately one month between measurements. The variables of environmental citizenship, environmental literacy, concrete environmental knowledge, and environmental (self-)education were chosen as potentially the most malleable parts of the SMEC which could naturally change over time in an educational setting. A total of 171 university students participated in the first measurement wave of the study, and 93 participants were retained in the second wave. The mean age of participants was 23 years of age (SD = 4), and 76.6% of participants were women, 21.6% were men, and 1.8% chose not to answer. Results uncovered that, in one month's time, participants' concrete environmental knowledge as well as environmental literacy significantly increased, while environmental (self-)education and environmental citizenship had positive yet insignificant effects. Path analysis revealed that measurements at the second measurement wave did not add any new variance that could not be explained through first wave measurements, highlighting that the development of the investigated variables requires more time.

Keywords: environmental citizenship; higher education; education for environmental citizenship; environmental knowledge



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1. Introduction

Public engagement in the process of mitigating and solving environmental issues is a key component to sustainable solutions for the future. One of the ways we can describe such engagement is environmental citizenship. Environmental citizens act both publicly and privately in a way that helps alleviate or prevent environmental issues, both through pro-environmental behavior and through civic action (Adamou et al. 2021; Hadjichambis et al. 2022).

Environmental citizenship is not a particularly novel concept (Hawthorne and Alabaster 1999), and it is something environmentally minded individuals naturally engage in. However, there has been a recent revival of research directed at studying environmental citizenship and ways it can be promoted (Dobson 2007; Reis 2020; Hadjichambis and Reis 2020; Hadjichambis and Paraskeva-Hadjichambi 2020a), especially through education (Hadjichambis and Reis 2020; Ariza et al. 2021; Hadjichambis and Paraskeva-Hadjichambi 2020a; Poškus 2022a; Telešienė et al. 2021). One of the more recent developments in this area of research is SMEC (Simple Model of Environmental Citizenship), a model of environmental citizenship designed specifically to be easy to use in interventions, with a focus on educational interventions (Poškus 2022b, 2023).

The SMEC is a simplified version of the model proposed by Hawthorne and Alabaster (Hawthorne and Alabaster 1999). SMEC's main difference from the aforementioned model is its simplified structure and the omission of variables describing individual traits (e.g., personality traits), for the reason that these variables tend not to change over time and therefore are impossible to target through interventions, even though they still remain

relevant in understanding the functioning of the model and can be used as moderating variables (Poškus 2023). The SMEC comprises abstract environmental knowledge, awareness of environmental issues, pro-environmental attitudes, desire to learn about environmental issues, engagement in environmental education, factual knowledge regarding environmental issues, perceived environmental literacy, desire to engage in environmental action (activism), and environmental citizenship (Poškus 2022b, 2023). All of the aforementioned variables have been shown to be relevant when understanding environmental behavior and together can be said to encompass environmental citizenship as a whole, as it is a complex concept (Hawthorne and Alabaster 1999). As a specific variable, environmental citizenship reflects active engagement in civic action for the betterment of environmental issues.

While educational approaches have been used to promote environmental citizenship (Telešienė et al. 2021), there is a lack of data on how environmental citizenship develops naturally over time without any intervention. Understanding the natural trends of environmental citizenship development should lend some insight into how to effectively promote it through interventions and how to best focus educational efforts.

Current Study

The present study is a cross-sectional study that takes advantage of the existing environmental education opportunities available to university students in Lithuania and was aimed to assess whether these opportunities effectively help individuals to become better environmental citizens over a span of approximately one month, with the first assessment conducted near the start of the academic year. The present study did not utilize any intervention and was aimed at observing natural change over time.

In the current study, a partial SMEC comprising environmental citizenship, environmental literacy, concrete environmental knowledge, and environmental (self-)education (Figure 1) was tested. The relationships depicted in the partial SMEC have been substantially supported by previous research (Hawthorne and Alabaster 1999; Poškus 2022b, 2023); however, the SMEC has not been in part or in whole tested longitudinally.

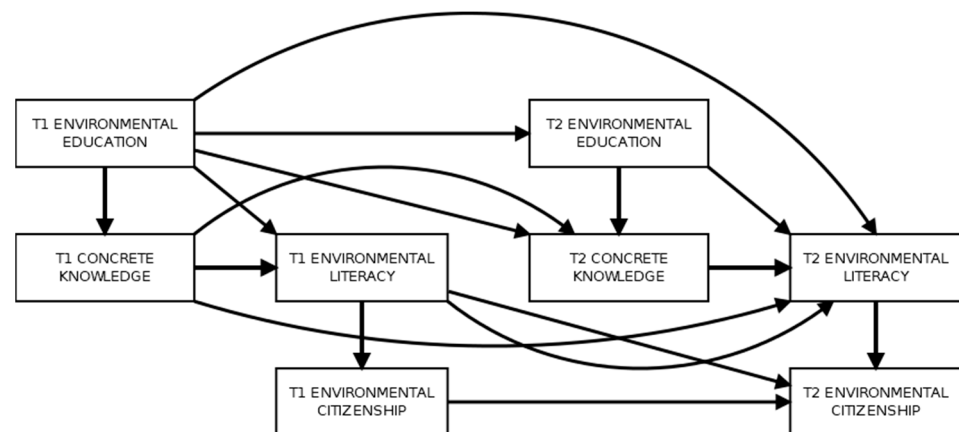


Figure 1. A partial representation of SMEC at two measurement timepoints.

The variables selected for the present study were chosen based on their practicality and change potential in a natural setting where some education directed at environmental issues is likely to occur. It was decided to include: environmental (self-)education, concrete knowledge regarding environmental issues, and environmental literacy, as they are most closely related to the outcomes of courses that deal with issues of sustainability which students naturally encounter in the university setting and throughout their university education.

Self-reported environmental (self-)education reflects one's exposure to educational materials related to environmental issues, concrete knowledge reflects objective competence regarding environmental issues, and self-reported environmental literacy in essence reflects one's perceived self-efficacy in finding relevant answers to questions regarding

environmental issues. Collectively, these variables directly or indirectly lead to environmental citizenship, i.e.,—one's self-reported engagement in environmental action publicly and privately.

While ideally one should test the whole SMEC, a longitudinal investigation of the full model would require an excessively high sample size; therefore, more general variables related to beliefs, activism, attitudes, and other aspects of environmental citizenship were not included to simplify the model. For exploratory purposes, it becomes more practical to test the most pertinent parts of the model which are the most likely to be susceptible to change over time, especially in an educational context.

The present study is exploratory; therefore, the objective of the study was to investigate the expected associations among variables depicted in Figure 1. As a working exploratory hypothesis, it was expected that at least a minor change in concrete environmental knowledge and literacy would be observed, as these variables are most closely related to formal educational outcomes.

2. Materials and Methods

2.1. Sample Characteristics

The sample of the present study consisted of 171 participants at the first measurement wave (T1) and 93 participants at the second measurement wave (T2) (54% participant retention). Participation in the study was voluntary; therefore, only those who participated in T1 and were interested in continuing their participation by following the link sent to them for T2 participated in the second wave. Participants were university students from two Lithuanian universities that have incorporated education for sustainability into their curricula. The T1 sample consisted of 131 females, 37 males, and 3 individuals who chose not to disclose their sex. Participant age ranged from 18 to 35 years of age, with a mean age of 23 years ($SD = 4$).

2.2. Procedure

Participants were recruited through convenience sampling and were invited to fill in online questionnaires. Participants were recruited by sending out emails inviting them to participate in the survey. All participants gave their active consent to participate in the study. Participants were asked to include their email addresses into the form for future contact. After one month's time participants, were contacted once more and were asked to participate in the second measurement wave of the study. Data were gathered from 23 September 2022 until 15 November 2022.

2.3. Measures

The questionnaire consisted of demographic variables asking participants to indicate their age, sex, employment status, and field of study. All variables are introduced in the order they were presented to the participants.

2.3.1. Concrete Environmental Knowledge

An objective knowledge test was used to assess concrete knowledge regarding environmental issues (Leeming et al. 1995). The test consists of 26 items with five alternative answers for each, one of which is correct. The updated Lithuanian translation of the measure was used (Poškus 2022b, 2023). The final scores were computed by summing up the number of correct answers, where correct answers were coded as 1 and incorrect answers as 0. The measure demonstrated sufficient internal consistency for T1 ($KR-20 = 0.464$) and T2 ($KR-20 = 0.312$).

2.3.2. Environmental (Self-)Education

Environmental (self-)education (Poškus 2022b) was assessed with 5 items. Items were rated on a 5-point scale ranging from 1 (completely disagree) to 5 (completely agree). The measure reflects one's willingness to engage in either formal or informal education

regarding environmental issues. Scores were averaged to compute the mean. The scale showed good internal consistency for T1 ($\omega = 0.893$) and T2 ($\omega = 0.789$). See Poškus (Appendix A) for the list of items (Poškus 2022b).

2.3.3. Environmental Literacy

Environmental literacy was assessed with a measure of 11 items, rated on a 5-point Likert scale ranging from 1 (completely do not know how) to 5 (completely know how to) (Hadjichambis and Paraskeva-Hadjichambi 2020b) (see Part B.2 of the ECQ). The measure reflects one’s perceived knowledge of how to contribute to mitigating environmental issues (Hadjichambis and Paraskeva-Hadjichambi 2020b; Poškus 2022b, 2023). The scale showed good internal consistency for T1 ($\omega = 0.876$) and T2 ($\omega = 0.708$).

2.3.4. Environmental Citizenship

Environmental citizenship was assessed with 3 items rated on a 5-point Likert scale, ranging from 1 (completely disagree) to 5 (completely agree). This measure was constructed by Hadjichambis and Paraskeva-Hadjichambi (Hadjichambis and Paraskeva-Hadjichambi 2020b) (see Part C.9 of the ECQ). The scale showed sufficient internal consistency for T1 ($\omega = 0.788$) and T2 ($\omega = 0.656$).

2.4. Analysis Strategy and Data Availability

The data were analyzed using JAMOVI (The_jamovi_project Jamovi 2023). Descriptive statistics were computed first to assess linear relationships among variables and to check whether the data were approximately normally distributed. Paired sample *t*-tests were conducted to see whether there were any significant changes in the variables from T1 to T2. Lastly, a longitudinal path-analytical model of the partial SMEC was tested. The data used in the present study (<https://osf.io/9typf>) as well as the pre-registration of the study (<https://osf.io/8u5hs>) are openly available on the OSF.

3. Results

The descriptive statistics of all the variables used in the analysis are presented in Table 1. The results indicate that the variables are approximately normally distributed and suitable for use in linear models. The observed linear relationships do not fully replicate the expected relationships among the variables comprising a partial representation of the SME. Nevertheless, the data are suitable for use in a path-analytical model and mean comparisons.

Table 1. Descriptive statistics of all used variables.

	M	SD	S	K	1	2	3	4	5	6	7					
1. T1 Environmental citizenship	3.39	0.84	−0.413	0.177	—											
2. T1 Environmental literacy	3.08	0.63	−0.071	0.951	0.48	***	—									
3. T1 Concrete environmental knowledge	18.98	2.72	−0.365	0.239	0.11	0.05	—									
4. T1 Environmental (self-)education	2.89	1.03	0.0127	−0.71	0.58	***	0.59	***	0.13	—						
5. T2 Environmental citizenship	3.32	0.82	−0.373	0.111	0.84	***	0.43	***	0.11	0.47	***	—				
6. T2 Environmental literacy	3.13	0.55	0.0964	−0.45	0.48	***	0.87	***	0	0.51	***	0.4	***	—		
7. T2 Concrete environmental knowledge	19.19	2.46	−0.044	−0.45	0.08	0.02	0.8	***	0.1	0.15	0.01	—				
8. T2 Environmental (self-)education	2.79	0.98	0.0916	−0.94	0.48	***	0.46	***	0.1	0.85	***	0.4	***	0.45	***	0.13

Note: *** $p < 0.001$; S—skewness, K—kurtosis.

After an initial investigation of descriptive statistics, a paired sample *t*-test was run for all variables of the partial SMEC, comparing means from T1 and T2 (Table 2). There was a statistically significant increase in self-reported environmental literacy as well as concrete environmental knowledge, but no significant increase in either environmental citizenship or environmental (self-)education, although the effect sizes are positive.

Table 2. Comparisons of means between T1 and T2 for all used variables.

Variable Pairs		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
T2 Environmental citizenship	T1 Environmental citizenship	0.698	92	0.487	0.072
T2 Environmental literacy	T1 Environmental literacy	2.514	92	0.014	0.261
T2 Concrete environmental knowledge	T1 Concrete environmental knowledge	2.996	92	0.004	0.311
T2 Environmental (self-)education	T1 Environmental (self-)education	0.456	92	0.649	0.047

A path-analytical structural model (see Figure 1 for a depiction) was constructed to relate the partial representations of SMEC from T1 to T2 (Table 3). The data fit the model well. For T1, only paths leading from environmental literacy toward environmental citizenship and from environmental (self-)education toward environmental literacy were statistically significant. For T2, all paths from corresponding T1 variables were significant predictors, indicating some stability over time in the variables. This is further supported by the fact that no variables measured at T2 were significant predictors for other variables, indicating that there was no significant shift in the expression of the variables or changes in their relationships that could not be explained through T1 measurements of those same variables.

Table 3. Results of the longitudinal structural model.

Dependent	Predictor	Estimate	SE	95% Confidence Intervals		β	<i>z</i>	<i>p</i>
				Lower	Upper			
T1 Environmental citizenship	T1 Environmental literacy	0.72488	0.1206	0.4885	0.9612	0.48419	6.0115	<0.001
T1 Environmental literacy	T1 Environmental (self-)education	0.30229	0.0632	0.1784	0.4261	0.51028	4.7836	<0.001
T1 Environmental literacy	T1 Concrete environmental knowledge	−0.00956	0.0197	−0.0483	0.0291	−0.04208	−0.4839	0.628
T1 Concrete environmental knowledge	T1 Environmental (self-)education	0.18113	0.2661	−0.3405	0.7027	0.06942	0.6806	0.496
T2 Environmental citizenship	T2 Environmental literacy	−0.13185	0.1819	−0.4883	0.2246	−0.088	−0.7249	0.469
T2 Environmental citizenship	T1 Environmental literacy	0.13896	0.1876	−0.2288	0.5067	0.09989	0.7407	0.459
T2 Environmental citizenship	T1 Environmental citizenship	0.76693	0.0636	0.6422	0.8917	0.82535	12.0502	<0.001
T2 Environmental literacy	T2 Environmental (self-)education	0.00179	0.0655	−0.1266	0.1301	0.00318	0.0274	0.978
T2 Environmental literacy	T2 Concrete environmental knowledge	−0.01551	0.0172	−0.0492	0.0182	−0.06906	−0.9015	0.367
T2 Environmental literacy	T1 Environmental (self-)education	0.05028	0.0672	−0.0814	0.182	0.09142	0.7482	0.454
T2 Environmental literacy	T1 Concrete environmental knowledge	0.01235	0.0178	−0.0226	0.0473	0.0586	0.6924	0.489
T2 Environmental literacy	T1 Environmental literacy	0.76663	0.0559	0.6571	0.8762	0.82568	13.7163	<0.001
T2 Concrete environmental knowledge	T2 Environmental (self-)education	0.09892	0.2946	−0.4785	0.6763	0.03939	0.3358	0.737
T2 Concrete environmental knowledge	T1 Environmental (self-)education	0.03135	0.3364	−0.6279	0.6906	0.0128	0.0932	0.926
T2 Concrete environmental knowledge	T1 Concrete environmental knowledge	0.75147	0.0595	0.6349	0.8681	0.80045	12.6316	<0.001
T2 Environmental (self-)education	T1 Environmental (self-)education	0.82727	0.0441	0.7408	0.9137	0.84808	18.7614	<0.001

Note: ML estimation was used and robust standard errors were computed. CFI = 0.974, TLI = 0.940, SRMR = 0.090, RMSEA = 0.109, $\chi^2(12) = 25.5$, $p = 0.014$. $R^2_{(T1\ Environmental\ citizenship)} = 0.23$, $R^2_{(T2\ Environmental\ citizenship)} = 0.70$.

4. Discussion

The partial model did not fully replicate previous research (Poškus 2022b, 2023) as the paths leading from concrete environmental knowledge toward environmental literacy and from environmental (self-)education toward concrete environmental knowledge were insignificant. It is not fully clear why these paths failed to be replicated, but one plausible explanation would be that the participants in the present study were at the start of their academic year and may have either overestimated or underestimated how much they were learning about environmental issues, and thus may not have reflected on their experience with full accuracy. There is also a possibility of other unknown confounding factors as

well. Lack of statistical power is also a likely explanation. While the present study was exploratory and did not aim for a specific statistical power to detect small effect sizes, the directions of the effects are consistent with what was expected.

A small yet statistically significant increase over time was found in concrete environmental knowledge and self-reported environmental literacy. This change occurred over roughly a month, indicating a natural development of both the actual and perceived competence of the participants regarding environmental issues. While not very profound, the observed change is encouraging and lends support to ideas of testing a more complete version of SMEC longitudinally and with larger samples. The present results provide a sort of benchmark for future studies of what natural changes one might expect when testing the model in settings where an intervention is used and there might not be sufficient resources for a control group.

The time between measurements was approximately one month, which may not be sufficient time for habits to change in a profound way; therefore, not seeing changes in environmental citizenship and environmental (self-)education as well as T2 variables not contributing significantly to the model beyond what T1 measurements explain is mostly expected. The findings, nevertheless, are informative for future explorations of the model in an intervention context.

Limitations and Future Directions

The present study deviated from its pre-registration because it became unrealistic to assess the whole SMEC longitudinally. Thus, only a part of the model that deals with environmental knowledge and literacy was assessed. Additionally, due to practical reasons, we were unable to gather the full planned sample of 200 observations for T1, which led to a T2 sample of only 93 participants and a total of 16 paths to be tested in this sample. This is a major limitation: first, the small sample might be too underpowered to detect some effects, and in general smaller samples tend to produce fewer representative effects; second, the attrition of participants might not have been random and more interested or motivated individuals might have chosen to continue participating in the study, thus further biasing the results (Nunan et al. 2018). Future studies should look to address these shortcomings by investigating a more complete SMEC in a substantially larger sample. The present survey also did not contain measures of individual traits, which also should be addressed by future research utilizing substantially larger samples that would allow for longitudinal model comparisons among personality trait clusters.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Vytautas Magnus University (No. 22-09-22). Date of approval: 22 September 2022.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data as well as the pre-registration of the study are available on the OSF platform.

Conflicts of Interest: The author declares no conflict of interest.

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