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Testing the simple model of environmental citizenship in a sample of adolescents

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Environmental citizenship and education for environmental citizenship have been identified as important areas to address, yet there is no simple way of studying either environmental citizenship or how effective is the education for it. In order to address this gap in the literature and to provide a practical model for future studies of environmental citizenship, especially in educational contexts, a Simple Model of Environmental Citizenship (SMEC), consisting of environmental (self-)education, abstract and concrete environmental knowledge, environmental awareness, pro-environmental attitudes, need for learning about environmental issues, need for environmental action, environmental literacy, and environmental citizenship was tested in a sample of adolescents. The objective of the study is to test the SMEC in a sample of adolescents in order to investigate its structure and functioning. The current sample consists of 236 adolescents from two schools in Lithuania recruited through convenience sampling. Structural equation modelling with DWLS estimation was used to test the SMEC. The SMEC, after small adjustments that are consistent with previous research, fit the data well. The SMEC provides a good starting point for future interventional and longitudinal studies with adolescents as well as other age groups.

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Introduction

Education for environmental citizenship has recently become one of the focuses of environmental psychologists and educators alike (Hadjichambis and Paraskeva-Hadjichambi, 2020a, 2020b; Hadjichambis and Reis, 2020; Poškus, 2022a, 2022b). There is no doubt that if we are to address our current environmental problems, a well-informed society needs to contribute to positive changes in policy as well as to contribute with their individual action. Citizens, however, are not necessarily informed to a sufficient degree that would allow them to engage in civic action productively and sustainably.

A recent study in a sample of young adults demonstrated that individuals lack factual knowledge that would allow them to effectively translate their environmental beliefs into sustainable and productive actions; furthermore, individuals tend to overestimate their knowledge regarding environmental issues, which might lead them to a false sense of expertise when engaging in civic participation directed at environmental issues (Liobikienė and Poškus, 2019; Poškus, 2022b).

Environmental citizenship is a relatively new concept, describing private and public civic participation through individual and collective action in order to tackle environmental problems and to develop a healthy relationship with nature (Hadjichambis and Reis, 2020; Poškus, 2022b). Environmental citizenship can be both understood as the broad collection of the beliefs, attitudes, and values that lead one toward constructive civic participation in addressing environmental issues, and as a narrow construct of civic participation in such activities (Poškus, 2022b, 2022a).

In the present study, the SMEC (Simple Model of Environmental Citizenship) is tested in a sample of adolescents. The model was derived from the model proposed by Hawthorne and Alabaster (1999) and was then simplified by Poškus (2022b) by reducing it to its core components to develop an intervention-friendly framework for practical research on the development of environmental citizenship. The model used in the present study is generally the same as in previous research (Poškus, 2022b), but the variable of environmental education was split into two lower-level factors, one of which assesses one's (self-)education, while the other—one's change in beliefs. This was done in order to bring the model closer to its practical usefulness as a change model for future educational interventions (see Fig. 1).

The SMEC used in the present study addresses several gaps in the existing literature on environmental citizenship and pro-environmental behaviour research in general. Firstly, it seeks to explain the disconnect between perceived knowledge on environmental issues and factual knowledge regarding these same issues, it further investigates how factual knowledge and perceived competence are related and predict civic engagement in environmental citizenship activities (Poškus, 2022b), all of which have been identified as important issues that need to be addressed (Akanyeti et al. 2020; Bravo and Farjam, 2022; Xie and Lu, 2022). The SMEC encompasses a variety of relevant variables, useful for longitudinal interventional studies that enable researchers to focus on separate aspects of promoting environmental citizenship, thus making it quite diverse in its application (Poškus, 2023). The SMEC was also developed with possible moderators in mind, especially focusing on the moderating effects of personality traits, making its application potentially more precise (Poškus, 2023).

There are several models of environmental citizenship, all of which serve a particular purpose and have their applications. One approach to models of environmental citizenship is conceptualizing it holistically, without necessarily specifying how different components of the model are related, but detailing what components comprise the general concept of environmental citizenship (Hadjichambis and Reis, 2020), or focusing on specific constructs relevant to environmental citizenship, such as value orientations (Sarid and Goldman, 2021). The Pedagogical Model of Education for Environmental Citizenship in Primary Education (Monte and Reis, 2021) is designed similarly to the aforementioned model but has a clear focus toward a specific age group and is partly based on insights from Hawthorne and Alabaster (1999). Other studies, however, regard environmental citizenship as a separate variable and define it through items representing civic participation in pro-environmental action (Takahashi et al. 2017). The SMEC unites the two common approaches as it is both a model that consists of variables that are often viewed as components of environmental citizenship, and a dependent variable of environmental citizenship reflected through an individual's engagement in civic action, making the model suitable for interventional and educational contexts.

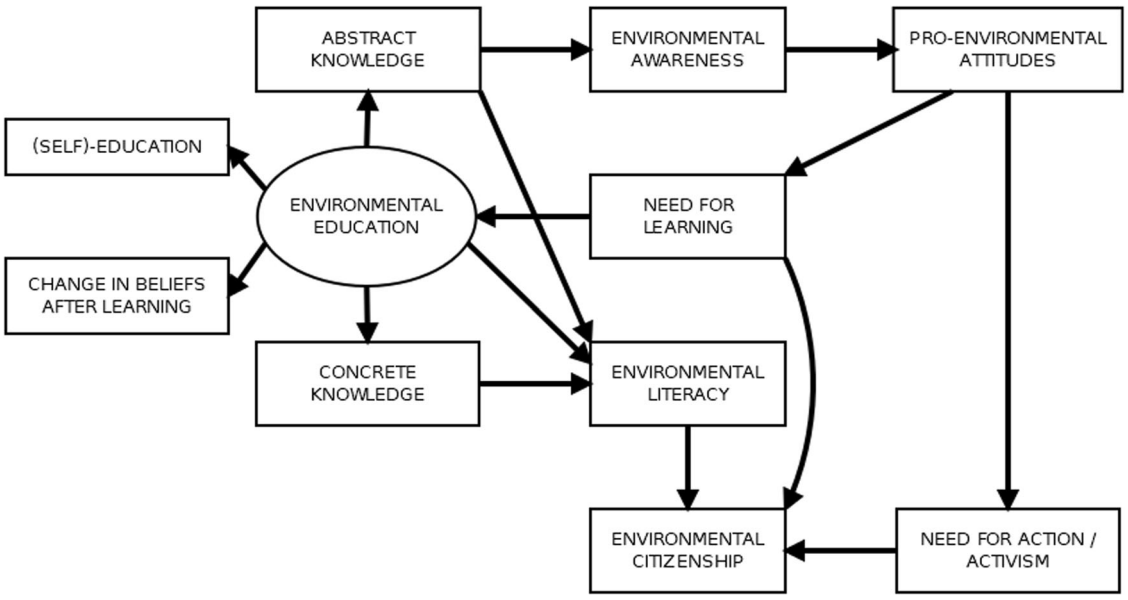

Fig. 1 . The SMEC—a simple model of environmental citizenship.

The model used in the present study is not assumed to be complete or its paths final. The SMEC is at an early stage of development and therefore additional paths and variables should be explored while retaining the idea of the model being a simple and practical representation of environmental citizenship.

While there is only one recent study to support the structure of the model in its current structure (Poškus, 2022b), it was originally derived from an exhaustive investigation of various relationships among different variables that could potentially explain environmental citizenship (Hawthorne and Alabaster, 1999). Additionally, there are several studies supporting each individual path of the model from previous research. Maurer and Bogner (2020) have investigated the relationship between ecological behaviour and environmental knowledge and values, while Liobikienė and Poškus (2019) have tested a modified Value-Belief-Norm model where the core predictor of the model is environmental knowledge. Additionally, environmental knowledge (as well as environmental values and behaviours) can be understood as a means of operationalizing environmental literacy (Maurer and Bogner, 2020), if one does not assess literacy as a separate subjective self-reported measure.

Knowledge is accrued through learning, and the more one feels the need to learn (is motivated to engage in learning activities), the more one potentially can further their understanding of a given subject. Thus, the need for learning in the SMEC is assumed to predict environmental education while itself being predicted by environmental attitudes. There is evidence that all of the aforementioned constructs are interconnected (Braun et al. 2018; Schmitz and Teixeira Da Rocha, 2018; White et al. 2018), but as one learns and develops more pro-environmental attitudes—one feels a greater need to learn about environmental issues (Del Rey et al. 2021), which in turn can result in higher engagement in learning. This highlights the cyclical nature of the SMEC, where education acts through environmental awareness and pro-environmental attitudes to promote learning, forming a loop. While the loop might get saturated at some point and would likely stop reinforcing itself, it is reasonable that a relatively uninformed individual would experience this feedback from having engaged in environmental education.

Lastly, it is assumed that the stronger one's pro-environmental attitudes, the more one will be motivated for civic action, which will ultimately lead to environmental citizenship as an expression of this need for action. There is research supporting the link between attitudes and activism (Tam, 2020). Ultimately, the model leads to environmental citizenship as its main dependent variable (Poškus, 2022b, 2022a).

Because the SMEC is in its early stages of development and has been tested only in a sample of emerging adults (Poškus, 2022b), it becomes difficult to predict how the model will function in a sample of adolescents. Therefore, based on the literature review presented above and on previous research using the SMEC, we propose these exploratory hypotheses:

H1. Environmental citizenship will be positively predicted by environmental literacy;

H2. Environmental citizenship will be negatively predicted by need for action (activism);

H3. Need for action (activism) will be negatively predicted by pro-environmental attitudes;

H4. Pro-environmental attitudes will be positively predicted by environmental awareness;

H5. Environmental awareness will be positively predicted by abstract environmental knowledge;

H6. Abstract environmental knowledge will be positively predicted by environmental (self-)education;

H7. Environmental citizenship will be positively predicted by the need for learning;

H8. The need for learning will be positively predicted by pro-environmental attitudes;

H9. Environmental literacy will be positively predicted by abstract environmental knowledge;

H10. Environmental literacy will be positively predicted by environmental (self-)education;

H11. Environmental literacy will be positively predicted by concrete environmental knowledge;

H12. Environmental (self-)education will be positively predicted by the need for learning;

H13. Concrete environmental knowledge will be positively predicted by environmental (self-)education.

The objective of the study is to test the SMEC in a sample of adolescents in order to investigate its structure and functioning. The proposed hypotheses correspond the paths in the model specified in Fig. 1. Bearing that in mind, the model will be subject to change based on the data; therefore, this study should be treated as exploratory and as a basis to build upon in future research.

Method

Sample characteristics. The sample, based on practical limitations, was planned to be at least 200 observations in order to run structural equation models. The current sample consists of 236 participants (55.9% female, 37.3% male, 6.8% chose not to disclose their sex), the mean age of the participants is 15.2 years (SD = 0.98). Secondary school children participated in the study; the sample was gathered with the help of two schools in Lithuania. In 2022, there were >950 secondary schools in Lithuania, although the exact number changes from year to year as some schools close and others open. In the present study, participants were recruited from schools with which the host university of the author of the study has cooperation agreements, thus the selection of schools was non-random in this regard. One school was located in Alytus, and the other—in Jonava, both of which are mid-sized cities in Lithuania, geographically representing the central and southern regions of the country. Both of the participating schools are publicly funded. It was planned to sample ~120 respondents from each school. Participants were invited to the study with the help of school staff in arranging possibilities for participation for those groups of students where the participation in the study would not interfere with their regular schoolwork, thus the selection of potential participant groups was not random. Non-random sampling of schools and participants was chosen for practical reasons and ease of access as the present study was intended as a pilot for further research. Permission to participate in the study was obtained from the schools, active written consent was obtained from the parents of the participating children and the children themselves actively consented to participate in the study and had the opportunity to withdraw from the study at any point no questions asked.

Procedure. The present study is cross-sectional. Data collection started on December 13th, 2021, and concluded on February 24th, 2022. Participants filled in online questionnaires under the supervision of their school's staff during a pre-arranged time that was convenient for each class. The survey was anonymous, and participation was voluntary.

Measures. The instrument the participants filled in consisted of additional measures that are not discussed in this paper. At the

start of the questionnaire participants were presented with a personality trait and value orientation measure, both of which assess fairly stable individual characteristics; thus, these measures are not likely to prime participants for the following items. Following these measures, variables relating to the model tested in the present study were assessed. The rest of the measures not discussed in the present study were at the end of the questionnaire and therefore could not prime the participants; these measures were directed at psychological need fulfilment and frustration and environmental self-identity as well as some questions regarding knowledge of current environmental initiatives and movements. The measures used in the present study are listed in the order they were presented to the participants. Item order was random within each measure, all measures were presented in fixed order.

Demographic variables. Participants indicated their age and biological sex. Participants had the choice not to disclose their biological sex.

Need for learning. A 10-item measure (Poškus, 2022b) originally adapted from the Attitude/Motivation Test Battery (Gardner, 1985) was used to assess the need for learning about environmental issues. All items were rated on a scale from 1 (completely disagree) to 5 (completely agree), example item: "learning about environmentally friendly behaviour is interesting to me." The scale showed good internal consistency ($\omega = 0.944$).

Abstract environmental knowledge. A total of 5 items were used to assess abstract environmental knowledge (Poškus, 2022b) (e.g., "I have good knowledge regarding environmental issues"). All items were rated on a scale from 1 (completely disagree) to 5 (completely agree). The scale showed good internal consistency ($\omega = 0.892$).

Concrete environmental knowledge. A 26-item objective multiple-choice knowledge test was used to assess concrete environmental knowledge (Leeming et al. 1995). The original measure consisted of 30 items, but several items were removed due to irrelevance (Poškus, 2022b). The measure demonstrated sufficient internal consistency (KR-20 = 0.813).

Environmental attitudes. The 15-item New Ecological Paradigm (NEP) (Dunlap, 2008) scale was used to assess environmental attitudes. All items were rated from 1 (completely disagree) to 5 (completely agree). The scale showed good internal consistency ($\omega = 0.802$).

Environmental education. Two components of environmental education were assessed: (self-)education and change in opinions after learning (Poškus, 2022b). All items were rated on a scale from 1 (completely does not apply to me) to 5 (applies to me completely). (Self-)education was assessed with five items (e.g. "during the past month I did research on environmental issues"), the scale showed good internal consistency ($\omega = 0.923$).

Change in opinion was assessed with three items (e.g., "During the past month, while refreshing my understanding of environmental issues, I learnt something that is true, but is inconsistent with my views"). The scale showed good internal consistency ($\omega = 0.865$).

A confirmatory factor analysis revealed that a two-factor solution fits the data well (CFI = 0.966, TLI = 950, RMSEA = 0.111, $\chi2(19) = 74.1$, $p < 0.001$) and all items loaded significantly into their respective factors with standardized Beta weights of at least 0.7.

Environmental literacy. Environmental literacy was assessed with an eleven-item measure originally part of the Environmental Citizenship Questionnaire (ECQ) (Hadjichambis and Paraskeva-Hadjichambi, 2020a). The measure assessed the degree to which one believes one knows how to contribute to the mitigation of environmental issues and ranges from 1 (I completely do not know how) to 5 (I fully know how). Example item: "I know how to contribute to the prevention of environmental problems." The scale showed good internal consistency ($\omega = 0.953$).

Environmental citizenship. Environmental citizenship was assessed with a three-item measure originally part of the Environmental Citizenship Questionnaire (ECQ) (Hadjichambis and Paraskeva-Hadjichambi, 2020a). The scale ranged from 1(very unlikely) to 5 (very likely). Example item: "I would try to change society in such a way that it becomes more environmentally friendly." The scale showed good internal consistency ($\omega = 0.880$).

Environmental awareness (consciousness). A four-item measure was used to assess environmental awareness (consciousness) (Poškus, 2022b). All items (e.g., "I understand the consequences of climate change") were rated on a scale from 1 (completely disagree) to 5 (completely agree). The scale showed good internal consistency ($\omega = 0.889$).

Need for action. Need for action was assessed with a six-item measure originally part of the Environmental Citizenship Questionnaire (ECQ) (Hadjichambis and Paraskeva-Hadjichambi, 2020a), items were rated on a four-point scale: (1—I have done that in the past half year, 2—I have done that in the past year, 3—I have done that but more than a year ago, 4—I have never done that). Items consisted of various activities one could participate in; example item: "have you participated in an environmental action group?" The scale showed good internal consistency ($\omega = 0.939$).

Analysis strategy and data availability. JAMOVI 2 was used for all analyses. DWLS estimation with robust standard errors was used for structural equation modelling because of the relatively small sample and possible deviations from normality in the variables (Li, 2016; Rhemtulla et al. 2012; Savalei, 2014; Tarka, 2017; Verhulst and Neale, 2021). Data used in this paper as well as the pre-registration of the study are openly available (see data availability statement at the end of the article). Normality was assessed based on skewness and kurtosis values for each variable (see Table 1) and using Mardia's coefficient for the whole model. While individual variables were normally distributed, Mardia's coefficient indicated a deviation from normality further grounding the use of DWLS estimation. While in some contexts samples as small as 50 observations might be enough to run structural equation models (Hoyle and Gottfredson, 2015), it is generally agreed that structural equation modelling is a method best suited for larger samples (Wolf et al. 2013) and the results of this paper should be interpreted cautiously.

Results

The descriptive statistics of all variables used in structural equation modelling are presented in Table 1. All variables, based on their skewness and kurtosis, roughly approximate a normal distribution and are suitable for use in linear models.

There is a strong correlation between environmental (self)-education and change in beliefs after environmental (self)-education, preventing the use of these two variables as separate components because of collinearity. Therefore, both components

Table 1 Descriptive statistics of the components of SMEC.

	M	SD	S	K	1	2	3	4	5	6	7	8	9
1. Need for action / Activism	1.76	0.891	1.18	0.238	—								
2. Environmental citizenship	3.14	0.906	−0.367	0.299	−0.049	—							
3. Environmental literacy	3.11	0.798	−0.183	0.664	0.056	0.533***	—						
4. Need for learning	3.21	0.888	−0.201	0.0294	0.025	0.536***	0.350***	—					
5. Environmental (self)-education (change in beliefs)	2.83	0.916	−0.331	0.0114	0.047	0.517***	0.486***	0.500***	—				
6. Environmental (self)-education	2.86	0.937	−0.198	−0.156	0.089	0.539***	0.510***	0.548***	0.887***	—			
7. Concrete environmental knowledge	11.2	4.96	−0.174	−0.619	−0.099	0.111	0.261***	0.021	−0.062	−0.018	—		
8. Abstract environmental knowledge	3.55	0.844	−0.591	0.682	0.034	0.434***	0.478***	0.517***	0.322***	0.368***	0.268***	—	
9. Environmental awareness	3.61	0.852	−0.425	0.234	−0.106	0.442***	0.527***	0.349***	0.245***	0.275***	0.443***	0.460***	—
10. Pro-environmental attitudes	3.51	0.525	0.388	−0.398	−0.064	0.378***	0.328***	0.219***	0.077	0.149*	0.494***	0.407***	0.607***

Note. S skewness, K kurtosis.
*$p < 0.05$, ***$p < 0.001$.

were used as indicators for a higher-order factor of environmental (self)-education in structural equation modelling.

The initial model, based on previous research (Poškus, 2022b) (Fig. 1), was tested first, but the model demonstrated poor fit to the data ($\chi2(30) = 157$, $p < 0.001$, CFI = 0.873, TLI = 0.809, RMSEA = 0.134, SRMR = 0.106). Exploration of modification indices revealed that the model would fit the data much better if a path from pro-environmental attitudes leading toward concrete environmental knowledge were added. After the inclusion of the additional path, the model fit improved substantially ($\chi2(29) = 37.5$, $p = 0.133$, CFI = 0.991, TLI = 0.987, RMSEA = 0.035, SRMR = 0.061). The estimates of the final model are presented in Fig. 2.

Hypotheses for the present study were proposed based on the paths of the model, expecting all the paths to be significant and positive, except for relationships with activism where lower scores indicate higher engagement in activism. While most hypotheses were supported by the data, lending further empirical support for the structure of the SMEC, some, however, were not. Namely, pro-environmental attitudes did not significantly predict the need for action (activism) (H3), nor did the need for action (activism) predict environmental citizenship (H2). Additionally, it was hypothesized that environmental (self-)education will positively predict concrete environmental knowledge, but the observed effect, although significant, is negative, thus the data did not support H13 as well. The newly added path from pro-environmental attitudes leading toward concrete environmental knowledge was significant and also improved the overall functioning of the model.

Out of the three hypothesized predictors of environmental citizenship, the most prominent one is environmental literacy, while the need for learning has a smaller weight, but is still highly significant. The need for action (activism) revealed itself to be an insignificant contributor to the prediction of environmental citizenship. Overall, the SMEC can explain ~60% of the variance of environmental citizenship (R^2 values are presented in Fig. 2). This estimate, however, might be conservative as path-analysis with means does not allow to adjust the effect sizes for the internal consistency of the scales.

Discussion

Overall, the data seem to support the current structure of the Simple Model of Environmental Citizenship (SMEC) and largely corresponds to what Hawthorne and Alabaster found while designing their model of environmental citizenship which was the basis for the current model (Hawthorne and Alabaster, 1999). While the model suggests a significant path from the need for action (activism) and this path was found to be significant in a sample of young adults (Poškus, 2022b), in the present sample of adolescents it did not reach significance. This can likely be explained by the lack of opportunities and autonomy at that particular age to meaningfully engage in environmental activism.

The negative and statistically significant effect leading from environmental (self-)education toward concrete environmental knowledge might indicate either an unwillingness to learn or lack of proper educational opportunities to acquire factual knowledge regarding environmental issues. It might also suggest the possibility that adolescents, searching for information on their own, are not necessarily able to discern high quality information. In essence, this finding suggests that there is might be a real need for factually driven and evidence-based education programs on environmental issues.

While in the present study there is a substantial and significant path from concrete environmental knowledge leading toward environmental literacy, previous research with young adults,

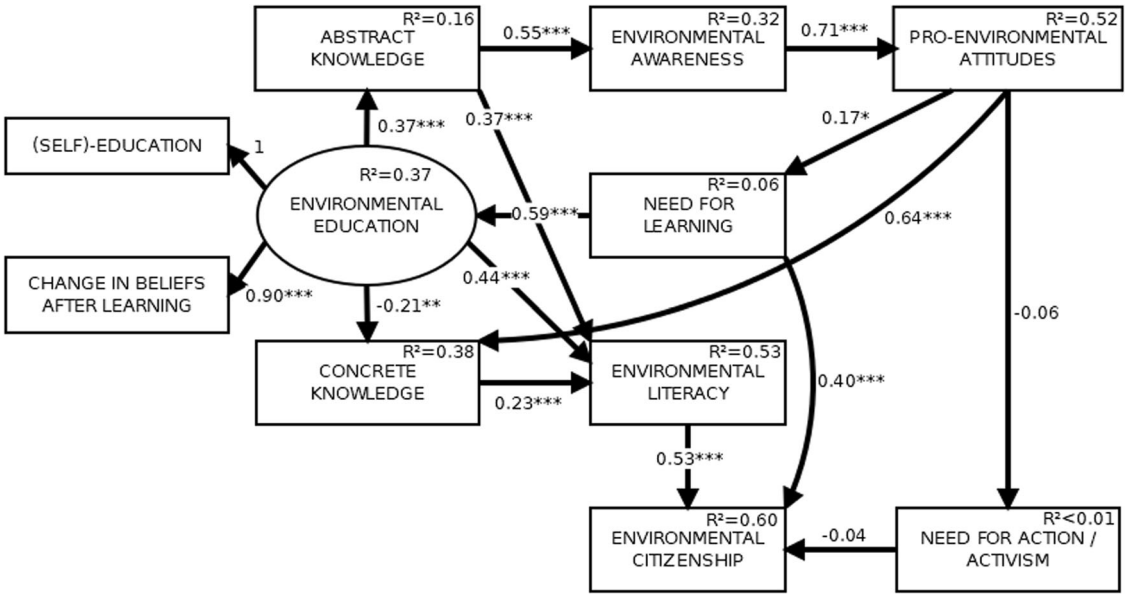

Fig. 2 Updated SMEC model with path coefficients. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

conducted in the same country, found this path to be insignificant (Poškus, 2022b). It is possible that for the present sample their everyday learning environment facilitates a more realistic attitude toward their own knowledge as they are not yet adults and are not socially pressured to be knowledgeable about everything. Therefore, in the present sample, participants are perhaps more capable of objectively assessing their level of knowledge. Taken together, the results suggest that the SMEC might function differently for different ages groups and even for different samples, therefore future exploration of possible moderators to best tailor the model to the target group should be explored.

The current model slightly differs from its previous iteration (Poškus, 2022b), in the present study the model has an additional path leading from pro-environmental attitudes toward concrete environmental knowledge. This direct path suggests that adolescents with more positive pro-environmental attitudes also tend to possess better factual knowledge regarding environmental issues, indicating that education should, in addition to being evidence-based, encourage the development of positive environmental attitudes and perhaps showcase the necessity of pro-environmental action in general.

Environmental (self-)education was constructed as a latent variable capturing both active pursuit of environmental knowledge as well as the change in beliefs regarding environmental issues that results from learning something new. This was done in hopes of reflecting the process of learning more completely. This change might have had at least some impact on the paths going from and toward this variable, and therefore future studies should investigate this further to get a better understanding of how to best capture engagement in environmental education and whether change of beliefs during learning is an important part of it.

Since the SMEC is intended as a model of predicting environmental citizenship (Hadjichambis and Reis, 2020), a part of which is civic action regarding the environment (Georgiou et al. 2021; Hadjichambis and Paraskeva-Hadjichambi, 2020a; Hadjichambis and Reis, 2020), and as noted before (Poškus, 2022b), any effective civic action needs to have a strong evidence basis in order to be sustainable and productive, change in beliefs while learning may play a prominent role in observing the effectiveness of interventions. However, this also raises the need to look into participants' willingness to change their beliefs when confronted with evidence that contradicts their current point of view. It may be that various individual characteristics such as values or personality traits would moderate the effectiveness of learning about environmental issues (Balundė et al. 2020; Jia et al. 2017; Poškus, 2020; Poškus and Žukauskienė, 2017).

Admittedly, the extent to which adolescents can engage in environmental citizenship is limited, but current adolescents will soon grow up to be young adults who, with their newfound autonomy, will start to engage in civic activities. Therefore, one of the key challenges for education for environmental citizenship, in the context of this model, would be to help citizens maintain their ability to objectively assess their competence regarding environmental issues and to acquire factual knowledge they can use to be active environmental citizens.

Although more research in more diverse samples is needed to see if the model structure is robust between age groups or different populations, it seems that the current iteration of the SMEC is a useful practical start for future interventional and longitudinal studies that would investigate either the development of environmental citizenship or the effectiveness of education for it.

Limitations and future directions. As with all research, the present study has some limitations. First, this study was done in only two schools in Lithuania, and this does not guarantee that the data completely represent all similarly aged adolescents in the country.

The SMEC, being a very recent model, still lacks enough empirical data to solidify its structure, thus the model should be considered as incomplete and future research should explore the possibility of expanding or perhaps simplifying the model. One of the first steps in improving the SMEC would be to investigate whether change of beliefs while learning deserves a separate place in the model rather than being part of a latent variable of environmental (self-)education. However, as the SMEC is intended to be a simple model, all expansions to the model should be strongly thought over as an increase in complexity

would likely lead to even less consistent results among samples and would likely diminish the practical value of the mode.

The SMEC may function differently for different age groups, thus the model should be explored in more varied samples to see which paths of the model are robust and which are age dependent.

Conclusions

The current iteration of the SMEC introduces an additional path to the model when compared to previous research done with young adults (Poškus, 2022b). The aforementioned change resulted in a well-functioning model in a sample of adolescents which can predict ~60% of the variance of environmental citizenship. Adolescents' pro-environmental attitudes directly predict their concrete knowledge regarding environmental issues, suggesting that fostering pro-environmental attitudes might be an effective way to increase the effectiveness of environmental education and education for environmental citizenship.

Data availability

Data (https://osf.io/qfsy4) as well as the pre-registration of the study (https://osf.io/ftnup) are available on the OSF platform.

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References

Akanyeti I, Kazimoglu C, Kanyemba T (2020) Perceived versus objective knowledge towards a sustainable solid waste management in Northern Nicosia. J Mater Cycles Waste Manag 22(6):1943–1952

Balundė A, Poškus MS, Jovarauskaitė L, Sarid A, Farangitakis G, Knippels M-C, Hadjichambis AC, & Paraskeva-Hadjichambi D (2020) Values, beliefs and environmental citizenship. Environ Discour Sci Educ https://doi.org/10.1007/978-3-030-20249-1_6

Braun T, Cottrell R, Dierkes P (2018) Fostering changes in attitude, knowledge and behavior: demographic variation in environmental education effects. Environ Educ Res 24(6):899–920

Bravo G, Farjam M (2022) Actions speak louder than words: attitudes, behaviour, and partisan identity in a polarised environmental domain. Energy Res Soc Sci 90:102547

Dunlap RE (2008) The new environmental paradigm scale: from marginality to worldwide use. J. Environ. Educ. 40(1):3–18

Gardner, RC (1985) The attitude/motivation test battery: technical. Report https://publish.uwo.ca/~gardner/docs/AMTBmanual.pdf

Georgiou Y, Hadjichambis AC, Hadjichambi D (2021) Teachers' perceptions on environmental citizenship: a systematic review of the literature. Sustainability 13(5):2622

Hadjichambis AC, Paraskeva-Hadjichambi D (2020a) Environmental citizenship questionnaire (ECQ): the development and validation of an evaluation instrument for secondary school students. Sustainability 12(3):821

Hadjichambis AC, Paraskeva-Hadjichambi D (2020b) Education for environmental citizenship: the pedagogical approach. https://doi.org/10.1007/978-3-030-20249-1_15

Hadjichambis AC, Reis P (2020) Introduction to the conceptualisation of environmental citizenship for twenty-first-century education. In Hadjichambis AC, Reis P, Paraskeva-Hadjichambi D, Činčera J, Pauw JB, Gericke N, & Knippels MC (eds.) Conceptualizing environmental citizenship for 21st century education. Environmental discourses in science education, vol 4. Springer. pp 1–14

Hawthorne M, Alabaster T (1999) Citizen 2000: development of a model of environmental citizenship. Glob Environ Change 9(1):25–43

Hoyle RH, Gottfredson NC (2015) Sample size considerations in prevention research applications of multilevel modeling and structural equation modeling. Prev Sci 16(7):987–996

Jia F, Soucie K, Alisat S, Curtin D, Pratt M (2017) Are environmental issues moral issues? moral identity in relation to protecting the natural world. J Environ Psychol 52:104–113

Leeming FC, Dwyer WO, Bracken BA (1995) Children's environmental attitude and knowledge scale: construction and validation. J Environ Educ 26(3):22–31

Li C-H (2016) The performance of ML, DWLS, and ULS estimation with robust corrections in structural equation models with ordinal variables. Psychol Method 21(3):369–387

Liobikienė G, Poškus MS (2019) The importance of environmental knowledge for private and public sphere pro-environmental behavior: modifying the value-belief-norm theory. Sustainability 11(12):3324

Maurer M, Bogner FX (2020) Modelling environmental literacy with environmental knowledge, values and (reported) behaviour. Stud Educ Eval https://doi.org/10.1016/j.stueduc.2020.100863

Monte T, Reis P (2021) Design of a pedagogical model of education for environmental citizenship in primary education. Sustainability 13(11):6000

Poškus MS (2020) What works for whom? investigating adolescents' pro-environmental behaviors. Sustainability 12(18):7313

Poškus MS (2022a) Developing an evidence-based educational course for environmental citizenship. iREEC 2022:10

Poškus MS (2022b) Toward the development and validation of a model of environmental citizenship of young adults. Sustainability 14:3338

Poškus MS (2023) A longitudinal investigation of a partial SMEC in a sample of university students. Soc Sci 13(1):15

Poškus MS, Žukauskienė R (2017) Predicting adolescents' recycling behavior among different big five personality types. J. Environ Psychol 54:57–64

Del Rey R, Ojeda M, Mora-Merchán JA, Nieves Sánchez-Díaz M, Morgado B, Lasaga MJ (2021) Environmental education: effects on knowledge, attitudes and perceptions, and gender differences. Int Res Geogr Environ Educ 0(0):1–22

Rhemtulla M, Brosseau-Liard PÉ, Savalei V (2012) When can categorical variables be treated as continuous? a comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. Psychol Methods 17(3):354–373

Sarid A, Goldman D (2021) A value-based framework connecting environmental citizenship and change agents for sustainability—implications for education for environmental citizenship. Sustainability 13(8):4338

Savalei V (2014) Understanding robust corrections in structural equation modeling. Struct Equ Model: Multidiscip J 21(1):149–160

Schmitz GL, Teixeira Da Rocha JB (2018) Environmental education program as a tool to improve. Children's Environ Attitudes Knowl Educ 8(2):15–20

Takahashi B, Tandoc EC, Duan R, Van Witsen A (2017) Revisiting environmental citizenship. Environ Behav 49(2):111–135

Tam KP (2020) Understanding the psychology X politics interaction behind environmental activism: the roles of governmental trust, density of environmental NGOs, and democracy. J Environ Psychol 71(2018):101330

Tarka P (2017) The comparison of estimation methods on the parameter estimates and fit indices in SEM model under 7-point likert scale. Arch Data Sci 2(1):1–16

Verhulst B, Neale MC (2021) Best practices for binary and ordinal data analyses. Behav Genet 51(3):204–214

White RL, Eberstein K, Scott DM (2018) Birds in the playground: evaluating the effectiveness of an urban environmental education project in enhancing school children's awareness, knowledge and attitudes towards local wildlife. PLoS One 13(3):e0193993

Wolf EJ, Harrington KM, Clark SL, Miller MW (2013) Sample size requirements for structural equation models. Educ Psychol Meas 73(6):913–934

Xie J, Lu C (2022) Relations among pro-environmental behavior, environmental knowledge, environmental perception, and post-materialistic values in China. Int J Environ Res Public Health 19(1):537

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Competing interests

The author declares no competing interests.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical

standards. The study was approved by the ethics committee of the Institute of Psychology of Mykolas Romeris University, approval number: 2/-2022.

Informed consent

Active written consent was obtained from both the participants and their legal guardians/parents. Participants were informed that they can withdraw from the study at any time without consequence.

Additional information

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