



DEVELOPING COMPLEX THINKING IN TEACHER EDUCATION FOR A SUSTAINABLE FUTURE: ENVIRONMENTAL ATTITUDES OF TEACHERS-IN-TRAINING

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ABSTRACT

Objective: This study investigates the relationship between complex thinking and environmental concern in university students, aiming to understand the influence of gender and age.

Theoretical Framework: The research is based on theories of environmental education and cognitive development, focusing on complex thinking models. These frameworks offer a basis for understanding the connections between cognitive processes and environmental awareness.

Method: The methodology uses a quantitative approach, involving university students as participants. Data collection was carried out through structured questionnaires designed to measure complex thinking and environmental concern, along with demographic variables like gender and age.

Results and Discussion: Results revealed that complex thinking correlates positively with environmental concern, with significant differences based on gender and age. Females were more likely than males to engage in complex thinking and show higher levels of environmental concern. The discussion contextualizes these findings within the theoretical framework, highlighting implications for environmental education. Discrepancies and limitations, such as sample size and scope, are also considered.

Research Implications: The practical and theoretical implications suggest that fostering complex thinking in environmental education is crucial. The study emphasizes the importance of addressing gender differences in strategies to enhance environmental concern and engagement.

Originality/Value: This study contributes by highlighting the relationship between complex thinking and environmental concern, with an emphasis on gender differences. Its relevance is evidenced by its potential to improve educational practices in fostering environmental awareness and action among diverse student populations.

Keywords: Environmental Education, Teacher Training, Complex Thinking, Higher Education, Sustainability.

DESENVOLVENDO O PENSAMENTO COMPLEXO NA FORMAÇÃO DE PROFESSORES PARA UM FUTURO SUSTENTÁVEL: ATITUDES AMBIENTAIS DE PROFESSORES EM FORMAÇÃO

RESUMO

Objetivo: Este estudo investiga a relação entre o pensamento complexo e a preocupação ambiental em estudantes universitários, com o objetivo de compreender a influência do gênero e da idade.

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Referencial Teórico: A pesquisa é fundamentada em teorias da educação ambiental e do desenvolvimento cognitivo, com foco em modelos de pensamento complexo. Esses referenciais fornecem uma base para entender as conexões entre processos cognitivos e consciência ambiental.

Método: A metodologia utiliza uma abordagem quantitativa, envolvendo estudantes universitários como participantes. A coleta de dados foi realizada por meio de questionários estruturados, projetados para medir o pensamento complexo e a preocupação ambiental, juntamente com variáveis demográficas como gênero e idade.

Resultados e Discussão: Os resultados revelaram que o pensamento complexo correlaciona-se positivamente com a preocupação ambiental, com diferenças significativas com base no gênero e na idade. As mulheres tendem a se engajar mais em pensamento complexo e a demonstrar níveis mais elevados de preocupação ambiental em comparação com os homens. A discussão contextualiza esses achados dentro do referencial teórico, destacando implicações para a educação ambiental. Discrepâncias e limitações, como o tamanho da amostra e o escopo, também são consideradas.

Implicações da Pesquisa: As implicações práticas e teóricas sugerem que promover o pensamento complexo na educação ambiental é crucial. O estudo enfatiza a importância de abordar as diferenças de gênero em estratégias para aumentar a preocupação e o engajamento ambiental.

Originalidade/Valor: Este estudo contribui ao destacar a relação entre pensamento complexo e preocupação ambiental, com ênfase nas diferenças de gênero. Sua relevância é evidenciada pelo seu potencial para melhorar práticas educacionais no fomento à conscientização e ação ambiental entre diversas populações estudantis.

Palavras-chave: Educação Ambiental, Formação de Professores, Pensamento Complexo, Educação Superior, Sustentabilidade.

DESARROLLANDO EL PENSAMIENTO COMPLEJO EN LA FORMACIÓN DE DOCENTES PARA UN FUTURO SOSTENIBLE: ACTITUDES AMBIENTALES DE LOS FUTUROS DOCENTES

RESUMEN

Objetivo: Este estudio investiga la relación entre el pensamiento complejo y la preocupación ambiental en estudiantes universitarios, con el objetivo de comprender la influencia del género y la edad.

Marco Teórico: La investigación se basa en teorías de educación ambiental y desarrollo cognitivo, enfocándose en modelos de pensamiento complejo. Estos marcos teóricos proporcionan una base para entender las conexiones entre los procesos cognitivos y la conciencia ambiental.

Método: La metodología utiliza un enfoque cuantitativo, involucrando a estudiantes universitarios como participantes. La recolección de datos se realizó a través de cuestionarios estructurados diseñados para medir el pensamiento complejo y la preocupación ambiental, junto con variables demográficas como género y edad.

Resultados y Discusión: Los resultados revelaron que el pensamiento complejo se correlaciona positivamente con la preocupación ambiental, con diferencias significativas basadas en el género y la edad. Las mujeres tendieron a involucrarse más en el pensamiento complejo y a mostrar niveles más altos de preocupación ambiental en comparación con los hombres. La discusión contextualiza estos hallazgos dentro del marco teórico, destacando las implicaciones para la educación ambiental. También se consideran discrepancias y limitaciones, como el tamaño de la muestra y el alcance.

Implicaciones de la Investigación: Las implicaciones prácticas y teóricas sugieren que fomentar el pensamiento complejo en la educación ambiental es crucial. El estudio enfatiza la importancia de abordar las diferencias de género en las estrategias para aumentar la preocupación y el compromiso ambiental.

Originalidad/Valor: Este estudio contribuye al resaltar la relación entre el pensamiento complejo y la preocupación ambiental, con énfasis en las diferencias de género. Su relevancia se evidencia por su potencial para mejorar las prácticas educativas en la promoción de la conciencia ambiental y la acción entre diversas poblaciones estudiantiles.



Palabras clave: Educación Ambiental, Formación de Docentes, Pensamiento Complejo, Educación Superior, Sostenibilidad.

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1 INTRODUCTION

Warnings about the generation of Global Environmental Change were already heard in the 1970s and 1980s (Manabe & Wetherald, 1980), clearly related to human activity and rapid population increase (Vitousek, 1994). This demographic increase has required more food availability, but with alarming increases in obesity and malnutrition (Swinburn et al., 2022). Although greater material well-being and longer life expectancy have been achieved, imbalances between different social strata have increased and inequalities between rich and poor countries have worsened (Dorkenoo et al., 2022).

These changes have come at a huge cost to the planet (Baste & Watson, 2022) and every year the data on resource waste, emissions and inequality worsen, bringing us closer to a point of no return (UN, 2022). Environmental destruction and deterioration of human health are effects of Climate Change that educational bodies are addressing at national and international levels (UN, n.d.; Cifuentes-Faura, 2022). To this end, university approaches to sustainability have been proposed as a crucial aspect of higher education's individual and collective commitment to the Sustainable Development Goals (SDGs) although higher education and its leadership are not yet realising their potential impact on a sustainable future (Kohl et al., 2022). University involvement in sustainability could create more interest and understanding that sustainability-oriented universities are indeed possible and that a much stronger role for higher education is needed when nations are discussing their future.

In general, there seems to be little support for transformative learning for sustainable development in universities in most quality assurance frameworks with the exception of the UK, which includes specific guidance on education for sustainable development in which transformative learning is prominently mentioned (Janssens et al., 2022). Despite this, there are some historical indications of higher education's commitment to sustainability and there have also been strong calls/offers within university networks to take on a crucial role in moving towards sustainable development that involves more than teaching about sustainability (Zhang & Wang, 2022), to engage in the environmental paradigm, the ecological paradigm and the new



environmental economic/social paradigm becoming the most widely used methodological tools for understanding people's values and attitudes towards the natural environment (Spash, 2020).

Calls from the international community for higher education to engage in policy formulation rather than simply educational implementation have been limited and the full potential of higher education institutions to take advantage of all opportunities, such as being living laboratories for sustainability, has yet to be realised (Vargas et al., 2019). At present, calls for participation are often still limited to training and research when scientific evidence is required. Thus, applications of Morin's (1992) Complex Thinking theories can be linked with contemporary advances in knowledge of educational organisation to lead to radical reform in the way we approach a sustainable future. This reform implies the mobilisation of loop or recursive thinking, i.e. a way of thinking capable of establishing a dynamic and generative feedback system between terms or concepts that remain both complementary and antagonistic.

The complexity paradigm thus presents itself as a bold challenge to the fragmentary and reductionist spirit that continues to dominate much of science. Complex thinking integrates ideas from different areas of knowledge by establishing intercommunications between different disciplines that are nowadays forging multidisciplinary knowledge (Barberousse, 2008). Thus, it can be argued that pro-environmental behaviour is so complex that it cannot be visualised through a single framework or diagram, including demographic factors, external (e.g. institutional, economic, social and cultural) and internal (e.g. motivation, pro-environmental) factors, environmental knowledge, environmental awareness, values, attitudes, emotions, locus of control, responsibilities and priorities (Kollmuss & Agyeman, 2010). In this sense, critical thinking towards sustainability can be a way to make decisions that do not imply negative effects on current or future generations while preserving natural resources and social well-being (Deniz, 2016).

Recognising the importance of Environmental Education to be introduced at all levels of school education, several studies have found it necessary to investigate whether trainee teachers are equipped with environmental attitudes and behaviours towards the environment so that they can disseminate this knowledge and shape the behaviour of their students. Nousheen et al. (2020) have argued for the need and potential of education for sustainable development in different teacher education programmes to improve students' attitudes towards sustainable development but there is no consensus on what are the most relevant elements of the specific competences of sustainability education in teacher trainees and how the development of these competences should be addressed (Brandt et al., 2019). While Redman et al. (2018) have pointed to the importance of strengthening subjective knowledge to achieve behavioural



change, Singer-Brodowski (2017) has highlighted the need to enhance pedagogical principles on sustainability as an essential aspect of educators' professional development.

Some studies have identified different gaps; Lahiri (2011) has suggested redesigning the activities involved in teacher training courses and assessing the determinant attitudes that can lead to responsible environmental behaviour, while Debrah et al. (2021) revealed that the lack of environmental education in most developing countries may be due to weaknesses in teachers' practical environmental curricula that are inadequate to respond to modern environmental challenges for sustainable development and cleaner production. For example, Kieu et al. (2016) have emphasised that the evaluation of sustainability education courses should focus more on attitude change and motivation than on theoretical knowledge.

Accordingly, to close the knowledge gap between young and old in sustainability and environmental sustainability education must be integrated into schools at all levels within developing countries. Furthermore, official data from the Andalusia region in Spain indicate that women have higher environmental concerns than men (Institute of Statistics and Cartography of Andalusia, 2018).

Therefore, the objectives of this study were: (i) to identify the environmental attitudes of the students of the Degree in Primary Education; (ii) to establish the existing differences in the environmental attitudes of the participants according to their level in the socio-demographic variables; (iii) to test the relationships between different socio-demographic variables with environmental attitudes; (iv) to establish the predictive capacity of the socio-demographic variables on the criterion variable (environmental attitudes).

In relation to the objectives, the following hypotheses guided and structured the research:

H1. Students of the Degree in Primary Education have positive environmental attitudes.

H2. Significant differences will be found in environmental attitudes according to gender and age (women and older students will show more positive environmental attitudes).

H3. Age will correlate positively with environmental attitudes.

H4. Gender will also correlate with environmental attitudes, and will do so in the following sense: female students are more likely to have more favourable environmental attitudes than male students.

H5. Age and gender will predict environmental attitudes, and will do so through positively valenced regression coefficients.



2 METHODOLOGY

2.1 PARTICIPANTS AND PROCEDURE

A cross-sectional study design was used based on the application of a self-administered online survey in the population of students of the Degree in Primary Education at the University of Granada, enrolled during the academic year 2022/2023. Participant data were collected in Google Forms and the survey was distributed by email. Sampling was by convenience, as all students enrolled in the Bachelor's Degree in Primary Education were invited to participate, and the final sample was drawn from those students who decided to participate freely.

Participants answered questions related to their socio-demographic data and a standardised scale on environmental attitudes. Before answering, information was provided about the purpose of the study, the anonymous treatment of data and informed consent. The data collected were processed in accordance with current legislation in Spain (Organic Law 3/2018 of 5 December on the Protection of Personal Data and Guarantees of Digital Rights). The data collection period was during the months of January and February 2023.

Finally, the sample was defined by 334 students in the second year of the Degree in Primary Education. As for the gender and age of the participants, 75.15% were women ($n = 251$) and 24.85% were men ($n = 83$). The majority percentage of women is common in university degrees in the field of education (Navarro & Casero, 2012). On the other hand, the age range was between 18 and 43 years ($M = 21.28$; $SD = 3.68$).

2.2 MEASURE

Environmental attitudes were assessed using the Environmental Attitudes to Specific Problems Scale (EAAPE). (Moreno et al., 2005). The EAAPE is composed of a total of 50 items, which are grouped into four main factors: (i) individual concern; (ii) social concern; (iii) confidence; (iv) complex thinking. The response mode of the scale followed a 4-point Likert-type format (1 = Not at all, 2 = Somewhat, 3 = Quite a lot, 4 = Very much). Thus, the scale scores ranged from 50 to 200 points, with higher scores indicating higher attitudes towards environmental problems. It should be noted that the EAAPE has been used in different studies, presenting good psychometric properties and internal consistency (Aznar-Díaz et al., 2019; Hinojo-Lucena et al., 2019). For this study, the reliability of the scale was good ($\alpha = .786$). For each factor, the following reliability values were obtained: individual concern ($\alpha = .677$); social



concern ($\alpha = .690$); confidence ($\alpha = .650$); complex thinking ($\alpha = .631$). Reliability was calculated using Cronbach's alpha coefficient.

2.3 DATA ANALYSIS

The different analyses were carried out with the statistical packages IBM SPSS, version 25 (IBM Corp., Armonk, NY). Descriptive (mean and standard deviation), inferential, correlational and predictive (linear regression analysis) analyses were performed.

The variables that will be conceptualised as predictors in the predictive phase of the research and as independent in the inferential phase are demographic: gender and age. However, the four variables, conceptualised as criteria in the predictive phase of the research and as dependent in the inferential phase, are: (1) individual concern; (2) social concern; (3) confidence; and (4) complex thinking.

For the analysis of the inferential results, we determined whether the variances of the attitudinal scores corresponding to the groups defined by the sociodemographic variables (gender and age) met the condition of homogeneity (homoscedasticity). To this end, Levene's test was performed, which allows us to test the hypothesis that the groups defined by a given variable come from populations with the same variance. For quantitative variables that meet this prerequisite, their means were compared using Student's t-test or analysis of variance (ANOVA). The lack of compliance with this prerequisite, in some quantitative variables, made it necessary to resort to non-parametric statistical tests.

3 RESULTS

3.1 DESCRIPTIVE RESULTS

The position of the sample on the four dimensions of the environmental attitudes questionnaire (individual concern, social concern, confidence and complex thinking) is described below. The results shown in Table 1 do not appear to show any significant differences between dimensions. All four have high means, located between the two highest points of the scale, thus confirming hypothesis 1. This means that future primary school teachers have a certain individual concern for environmental care ($M = 3.44$), consider that socialisation in the immediate environment is key to environmental awareness (social concern) ($M = 2.70$), have the self-confidence to contribute to the fight against environmental problems ($M = 3.00$) and



develop complex thinking in order to have their own position on environmental issues ($M = 3.08$). On the other hand, the standard deviations are not characterised by a high magnitude and it can be deduced from them, provided that the distributions are assumed to be normal, that most of the participants in the sample obtain means around point 3 (fairly) on the scale.

Table 1

Means and standard deviations on the dimensions.

Dimension	N	Mean	Standard deviation
Individual concern	334	3.44	.31
Social concern	334	2.70	.33
Confidence	334	3.00	.37
Complex thinking	334	3.08	.31

N = number of individuals.

3.2 INFERENCIAL RESULTS

The inferential analyses carried out are presented below, ordered by independent variable:

For the gender variable, the different sizes of the groups being compared ($N_{men} = 83$, $N_{women} = 251$) made it advisable to verify the equality of variances or homoscedasticity before proceeding to compare the means. For this purpose, the Levene test was performed. The following results were obtained for each dependent variable: individual concern: $F(1,332) = .175$, $p = .676$; social concern: $F(1,332) = .160$, $p = .689$; confidence: $F(1,332) = 5.040$, $p = .025$; and complex thinking: $F(1,332) = 1.303$, $p = .255$. Therefore, we assume that variances are equal, except for the "confidence" variable. The lack of homogeneity of variance in this variable leads to the need to resort to the non-parametric Mann-Whitney U test, while the Student's t-test was applied for the rest. The results are shown in Table 2.



Table 2

Basic descriptive statistics of the levels of the gender variable in each of the attitudinal variables, and results of Student's t-tests and Mann-Whitney U-tests.

Dimension	Gender	Mean	Standard deviation	t	Df	p	
Individual concern	Man	3.37	.31	-2.038	332	.042	
	Woman	3.46	.31				
Social concern	Man	2.64	.33	-1.795	332	.074	
	Woman	2.71	.33				
Complex thinking	Man	2.97	.32	-3.004	332	.000	
	Woman	3.12	.30				
				U	Df	z	p
Confidence	Man	2.92	.33	8911,00	332	-1.97	
	Woman	3.02	.38				

t = statistic from Student's t-test; Df = degree of freedom; *p* = p-value; U = statistic from de Mann-Whitney U-test.

From the values shown in the table above it can be deduced that there is a significant difference between male and female students in all variables, except for the social concern variable. Female students have a greater personal concern for environmental problems, have greater self-confidence to contribute to their solution and develop more complex thinking skills than male students.

In order to test for differences in attitudes by age, participants were grouped into three age groups: 18-21 years, 22-25 years, and 26 years and older. Since the size of the groups was unequal (N₁₈₋₂₁ = 214, N₂₂₋₂₅ = 92, N_{≥26} = 28), Levene's test was carried out to check compliance with the parametric assumption of homogeneity of variances with the following results: individual concern: F (2.331) = 2.797, *p* = .062; social concern: F (2.331) = 1.212, *p* = .299; confidence: F (2.331) = .028, *p* = .011; and complex thinking: F (2.331) = 1.057, *p* = .349. In the variables "individual concern", "social concern" and "complex thinking", homogeneity of variances was admitted, which allowed the ANOVA test to be applied. For the variable "confidence", however, the non-parametric Kruskal-Wallis test was used. Table 3 shows the results of both tests.



Table 3

Basic descriptive statistics of the levels of the age variable in each of the attitudinal variables, and results of the Kruskal-Wallis (X^2) and ANOVA (F) tests.

Dimension	Age	Mean	Standard deviation	F	Df	p
Individual concern	18-21	3.416	.338	3.042	2	.049
	22-25	3.509	.281			
	≥ 26	3.344	.249			
Social concern	18-21	2.694	.350	.185	2	.831
	22-25	2.718	.320			
	≥ 26	2.700	.295			
Complex thinking	18-21	3.065	.334	1.751	2	.175
	22-25	3.139	.294			
	≥ 26	3.109	.275			
				X^2	Df	p
Confidence	18-21	3.005	.391	.358	2	.836
	22-25	2.999	.338			
	≥ 26	2.968	.309			

F = F-statistic from the ANOVA (or F-test); Df = degree of freedom; p = p-value; X^2 = Kruskal-Wallis chi-square statistic.

It was only possible to reject the null hypothesis and accept the existence of significant differences between the means of the age groups in the variable "individual concern". For this variable, the Bonferroni test was applied to identify the pairs of means where statistical significance was reached. Of the three possible two-way comparisons, only the youngest group (18, 19, 20 and 21 years) comes close to a significant difference from the intermediate group (22, 23, 24 and 25 years), as can be seen in the following table (Table 4).

Table 4

*Concentration-mortality curve, LC50 and LC90 of the aqueous extract of seeds of *Passiflora edulis* on *Raoiella indica*.*

Comparison between groups	Difference in means	Standard error	p
18-21	22-25	-.093	.039
	≥ 26	.016	.062
22-25	18-21	.093	.039
	≥ 26	.110	.068
≥ 26	18-21	-.016	.063
	22-25	-.110	.068

p = p-value.

Overall, it can be said that hypothesis 2 is partially verified due to the significance obtained in the gender variable and not so much in the age variable.



3.3 CORRELATIONAL RESULTS

In a new phase of analysis, the socio-demographic variables (gender and age) were correlated with those corresponding to the central object of study in this research - environmental attitudes - giving rise to the coefficients shown in Table 5. The first result that would stand out would be the low intensity of the relationships, only in the complex thinking factor is there a positive and significant correlation with the gender and age variable. In the case of gender, female students are more likely than male students to develop more complex thinking in understanding environmental issues.

Only in the gender variable were two more correlations found, in personal concern and confidence. That is, women are more likely to have a greater individual concern for environmental care and more self-confidence to contribute to it.

In the absence of further significant correlations with the other factors, hypotheses 3 and 4 cannot be confirmed.

Table 5

Correlations between socio-demographic variables (gender and age) and environmental attitude factors.

	Individual concern	Social concern	Confidence	Complex thinking
Gender	.111*	.098	.113*	.209**
<i>p</i>	.042	.074	.038	.000
Age	.048	.070	.049	.112*
<i>p</i>	.384	.200	.373	.040

Note. The coefficients correlating gender with attitudinal factors are point biserial. The rest are Pearson coefficients; * $p < .05$ (bilateral); ** $p < .01$ (bilateral); p = p-value.

3.4 PREDICTIVE RESULTS

In this section, three predictive models, which will act as criterion variables, were developed based on the correlation coefficients in the table above. The variables whose correlation with the criterion variables reached statistical significance were entered into the three models. Specifically, the following predictors were subjected to linear regression analysis in each of the three models:

In relation to the prediction of individual concern, the gender variable was introduced into the regression analysis. The model was configured as follows: $\beta = 0.108$, $t = 1.983$, $p < .048$. In this case, significant difference was reached. The final model explains only 1.4% of



the variance, as indicated by the coefficient of determination, $R^2 = 0.014$. Therefore, the model has a very limited explanatory power.

In relation to confidence, the gender variable was introduced into the regression analysis. The model was configured as follows: $\beta = 0.113$, $t = 2.079$, $p < .038$. As above, significant difference was reached. The final model explains only 1.3% of the variance, as indicated by the coefficient of determination, $R^2 = 0.013$. Therefore, this model also has a very limited explanatory power.

On the prediction of complex thinking, the variables gender and age were introduced in the regression analysis. The model was configured as follows: gender, $\beta = 0.203$, $t = 3.788$, $p < .000$; age, $\beta = 0.099$, $t = 1.851$, $p < .065$. Therefore, a significant difference was only reached for the gender variable. The final model explains only 5.4% of the variance, as indicated by the coefficient of determination, $R^2 = .054$. Therefore, the model has a limited explanatory power, although superior to the previous ones.

Since all three predictive models have considerable explanatory power, hypothesis 5 is partially confirmed.

4 DISCUSSION AND CONCLUSIONS

The results of this study suggest that trainee primary school teachers have a moderate individual concern towards environmental care. In this sense, they have the self-confidence to mobilise and act on environmental problems (Nousheen et al., 2020). Although some studies (Debrah et al., 2021; Kieu et al., 2016; Lahiri, 2011), reported gaps in teacher training, the study participants showed their ability to develop complex thinking in environmental problems.

In turn, the significant differences found between women and men (except for social concern), indicated the trend of official data that women have a greater personal concern towards environmental issues (Instituto de Estadística y Cartografía de Andalucía, 2018). At the same time, they develop more complex thinking skills than men, which is an essential characteristic for understanding environmental issues (Deniz, 2016; Redman et al., 2018).

In addition, two further correlations were found only in the gender variable, in personal concern and confidence. That is, women are more likely to have a greater individual concern for the environment and greater self-confidence to contribute to it. These results are consistent with other research indicating that women are more environmentally aware and more likely to adopt responsible environmental behaviours (Debrah et al., 2021; Kieu et al., 2016).



These differences make it clear that environmental training programmes should emphasise the need to focus on the development of specific environmental education competencies for trainee teachers (Brandt et al., 2019; Janssens et al., 2022).

In summary, the results of the present study indicated that female students are more likely to develop complex thinking, greater personal concern and greater self-confidence to contribute to environmental care.

With regard to the objectives of the study, these were satisfactorily addressed, since environmental attitudes were identified, differences between socio-demographic variables were established, the relationships between them were tested and the predictive capacity of these variables was established. In turn, the supported hypotheses were hypothesis 1 and partially supported hypothesis 2 and hypothesis 5, hypotheses 3 and 4 were rejected.

Limitations of the study include: (i) selection bias, the fact that the study participants are university students from a single institution could limit the generalisability of the results to other populations or contexts; (ii) measurement of the variables, although a validated questionnaire was used to measure the variables of interest, it is possible that the measures were not sufficient to capture all relevant dimensions of the constructs; (iii) being a cross-sectional study, it is not possible to establish causal relationships between the variables and only correlations can be obtained. It would be interesting to replicate the study in the future with a longitudinal design in order to follow participants over time. Future lines of research could therefore explore the role of other factors in the development of complex thinking and concern for the environment, such as previous education, specific training in environmental issues and practical experience.

In terms of practical implications, the results of this study suggest that educators and educational institutions should pay more attention to promoting complex thinking and environmental awareness among students, especially among males. This could be achieved by integrating environmental education into the curriculum and promoting participation in practical activities related to the environment. Furthermore, the results also suggest that attention should be paid to gender differences in the promotion of environmental awareness and complex thinking, which could be relevant for the implementation of environmental education policies and programmes in different educational contexts.

Finally, the results of this study highlight the importance of education for sustainable development in teacher education and the need to strengthen sustainability-related knowledge and skills in teacher education programmes.



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