

# Evaluation of environmental competencies in Higher Education Institutions (HEI). Case study: Escuela Politécnica Nacional, Ecuador

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## Abstract

Environmental competencies are defined as a set of skills, knowledge, attitudes, and values that individuals put into play in different contexts and that are achieved through Environmental Education. These are divided into environmental knowledge, attitudes, and behaviors. The aim of the research is to evaluate environmental skills of students and professors at the Escuela Politécnica Nacional (EPN) of Ecuador through a mixed, qualitative, and quantitative approach, for which the questionnaire proposed by Álvarez García (2015; 2017) was adapted and applied. The combination of both approaches and the descriptive statistical analysis made it possible to propose management strategies that allow increasing environmental competencies for the specific context. It was determined that the methodological competencies and that the issues with the least evaluation are those of attitude and collective behavior, provoking the reflection that individual and small actions count in aspects of environmental sustainability, but coordinated solutions are also required at all levels.

*Keywords:* environmental education; environmental competencies; environmental management.

# Evaluación de las competencias ambientales en las Instituciones de Educación Superior (IES). Estudio de caso: Escuela Politécnica Nacional, Ecuador

## Resumen

Las competencias ambientales se definen como un conjunto de habilidades, conocimientos, actitudes y valores que los individuos ponen en juego en diferentes contextos y que son conseguidos mediante la Educación Ambiental, estas se dividen en conocimientos, actitudes y comportamientos ambientales. La investigación pretende evaluar las competencias ambientales de los estudiantes y los profesores de la Escuela Politécnica Nacional – EPN, bajo un enfoque mixto, cualitativo y cuantitativo, para ello se adaptó y aplicó el cuestionario propuesto por Álvarez García (2015; 2017). La combinación de ambos enfoques y el análisis estadístico descriptivo permitieron proponer estrategias de gestión que permitan incrementar las competencias ambientales para el contexto específico. Se determinó que las competencias metodológicas y que los temas con menor evaluación son los de actitud y comportamiento colectivo, provocando la reflexión de que las acciones individuales y pequeñas cuentan en aspectos de sostenibilidad ambiental, pero también se precisan soluciones coordinadas en todos los niveles.

*Palabras clave:* educación ambiental; competencias ambientales; gestión ambiental.

## 1 Introduction

Today's society is facing an environmental crisis due to rapid population growth, pollution, excessive use of resources, unsustainable production and consumption

patterns and the deterioration of ethics regarding the land [1], a dilemma that can be bent if one chooses to follow the path of sustainable development, making it imperative to promote environmental skills [2,3].

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Education in sustainability issues and in other transversal skills is how individuals will be able to face today's challenges and change their lifestyle [2]. Consequently, the faculty and students of Higher Education Institutions - HEIs require correct training in Environmental Education that generates competencies, skills, and abilities in professions to promote actions in favor of the environment [4].

Environmental Education – EE is defined as an essential tool to make changes in knowledge, behavior, values, and lifestyles to achieve sustainability [5]. EE is a process in which the individual becomes aware of their global reality, evaluating interdependent relationships between individuals and the environment [6]. In addition, EE is an educational process where the relationship between man and his environment is fostered, promoting the development of values and new attitudes that contribute to the rational use of resources and alternative solutions to environmental problems [7].

Lastly, Environmental Education includes the acquisition of thinking, affective, moral, and ethical information [8], reaching a certain level of Environmental Literacy - EL, a term coined in 1969 by Roth, who asserts that achieving EL is the goal of Environmental Education. Environmental Literacy provides a set of cognitive and affective mechanisms in favor of environmental care [9] and is defined as the ability to perceive and interpret the health of the environment, and in turn to make the decisions appropriate to maintain, restore and improve environmental systems [10].

Several studies have been developed to evaluate Environmental Literacy. Six areas supporting Environmental Literacy are proposed: i) environmental sensitivity; ii) environmental knowledge; iii) environmental skills; iv) environmental attitudes and values; v) active participation; vi) personal involvement and responsibility [10]. In 1993 the North American Association for Environment Education - NAAEE outlined Guidelines for Excellence in Environment Education. These guidelines meant to establish and disseminate basic criteria for environmental literacy, promoting knowledge, developing skills, and promoting environmentally relevant decision-making [11].

In 1997 the Wisconsin Center for Environment Education determined the four components of Environmental Literacy: i) affective determinants; ii) personal initiative of responsible behavior; iii) responsible environmental behaviors and actions; and iv) knowledge on environmental issues [12, 13].

For 2000 the NAAEE drafted the Guidelines for Learning (K-12), built on four components: i) questioning skills, interpretation, and analysis of environmental issues; ii) knowledge about environmental systems and their processes; iii) skills to understand and address environmental issues; and iv) civic and environmental responsibility [3].

In 2005 a study seeking to evaluate Environmental Literacy in the United States was carried out. Three environmental components were determined: i) environmental awareness, but which lacks understanding of a problem, its causes and consequences; ii) knowledge of personal behavior, a component that implies awareness and action to participate in a behavior that contributes to the improvement of the environment; and, iii) true environmental literacy involves understanding the principles of an

environmental issue, skills to research about the issue and how to apply that information [14].

Studies focused on Environmental Education and Environmental Literacy were also carried out in Europe. A paper intended to evaluate environmental education and literacy of primary and secondary school students in Israel based on three components: i) environmental knowledge; ii) environmental attitudes; and iii) environmental behaviors [15].

In Asia, a study defined six components of Environmental Literacy: i) basic knowledge of ecology and natural history; ii) knowledge about environmental issues; iii) political and socio-environmental knowledge; iv) cognitive-type skills; v) responsible environmental behavior; and iv) environmental effects [16].

Environmental Literacy studies share the determinants of environmental awareness, knowledge, attitudes, and behaviors. Reasonably, individuals with EL, in the first instance, will have the ability to understand and define how natural systems work and interaction of humans with the environment. They will then be able to identify and evaluate environmental problems and make environmental conservation decisions based on their knowledge and experience.

Finally, individuals with higher EL will be able to assess the impacts and consequences of actions on the environment, propose and select alternatives for improvement, and implement actions to improve the environment individually and collectively [10,12,17]. Consequently, individuals having completed environmental education will develop a certain degree of environmental literacy, permeating environmental competencies that integrate knowledge, skills, attitudes, and environmental behaviors that allow managing the complexity of environmental problems.

### ***1.1 Environmental competencies***

Competence is defined as that complex action system that encompasses cognitive skills, attitudes, values, emotions, and other non-cognitive components [18]. Also, competence is defined as what we learn, how we apply it, and the attitudes, values, and emotions that underlie teaching and learning [19]. Likewise, competence is described as an integrating category having implicit knowledge, skills, behaviors, and values [20]. In other words, competence will be understood as an individual integrated quality of a person in each sphere of being [21].

Therefore, environmental competencies can be defined as a complex system made up of knowledge, abilities, skills, values, and attitudes that individuals execute in different contexts: social, educational, family or work, to solve situations related to environmental problems [22].

Thus, environmental competencies are understood in terms of capabilities, combining knowledge, attitudes, values, emotions, and motivations to achieve a sustainable and responsible society with the environment [23]. Similarly, the term is associated with the ability to transfer and comprehensively apply knowledge and skills so as to design and manage environmentally safe activities (actions, behavior) in problematic environmental situations [21].

Environmental competencies can be acquired through Environmental Education and fulfill two purposes, as a means and a result, since they provide the necessary means for a holistic understanding of complex problems and, as a result, they provide the skills and aptitudes necessary to manage the complexity of environmental problems [2].

Three components of environmental competence are identified: i) Axiological (value-motivational); ii) Cognitive (meaningful, knowledgeable); and iii) Activity (practical, technological) [24]. Environmental competence is divided into three main groups: i) environmental cognitive skills that describe the understanding of concepts and description of environmental problems on a local, national and global scale; ii) attitudinal competencies that seek the value of humans with regard to the environment and responsibility in light of environmental problems; and, iii) methodological competencies that allow knowing if individuals exercise behaviors of respect towards the environment on a daily basis and participate in pro-environmental actions [12, 17].

Generally, Higher Education Institutions - HEIs integrate environmental subjects in the curricula of various university majors, thus promoting the development of environmental skills [4], as they seek to develop the ability to solve environmental problems, the ability to integrate different dimensions that can be economic, cultural, social, political, physical and biological with the environment, the ability to perceive what is global from a local perspective and objectively reflect on individual behavioral models and groups in force in society [25].

## 2 Methodology

A mixed approach is used, a quantitative one since primary information collected was analyzed using data collection adapted from the questionnaire proposed by Álvarez García (2015), on EPN professors and students, and qualitative since it addressed the analysis of the specific context and the application of semi-structured interviews to expert professor/researchers in the environmental area. The combination of approaches allows broadening the understanding of the case study, establishing a baseline for environmental competencies of EPN professors and undergraduate students to finally propose strategies to improve their development and application. Fig. 1 shows the combination of both approaches used in the study.

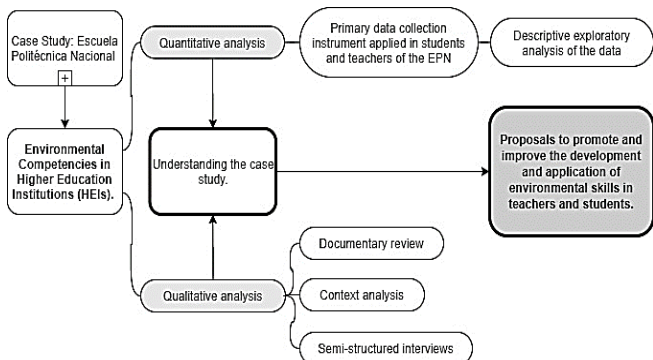


Figure 1. Research methodology with a mixed approach. Source: Prepared by the authors.

For data processing, the non-probabilistic quota sampling technique was used on a total of 2,315 people: 648 professors and 1,667 undergraduate students [26]. A confidence level of 96% and a margin of error of 7% were used, requiring a sample of 181 members of the university community, necessitating 51 observations from the control group of professors and 130 from students.

The questionnaire proposed by Álvarez-García (2015) allowed to evaluate the environmental competences of college students preparing to be professors of primary education at the University of the Balearic Islands in Spain. This is made up of 3 sections adapted to the reality of the context, considering that Ecology and Environment is taught in all the EPN departments:

Table 1. Cognitive, attitudinal, and methodological environmental skills.

	Specific skills	In-depth topics
<b>SECTION A</b>		
Personal information	N/A	N/A
<b>SECTION B1</b>		
Cognitive environmental skills.	(C1) Know the main concepts and principles as related to the earth as a system and the relationships between society and the environment.	Knowledge of the main environmental concepts and principles. Knowledge about the interactions of society and the environment. Knowledge and description of problems and issues related to the environment and society.
	(C2) Know the main environmental problems on a local, regional, and global level.	Environmental problems on local, national, and global levels.
<b>SECTION B2</b>		
Attitudinal environmental competencies.	(C3) Assess the attitudes of human beings towards the environment and responsibility in the face of environmental problems.	Collective responsibility attitudes. Individual responsibility attitudes. Government responsibility attitudes.
	(C4) Demonstrate values and attitudes of respect and equity towards nature and society.	Evaluate the feelings and values related to the environment.
	(C5) Assess the motivation and intentions that people must participate in solving environmental problems.	Evaluate the motivation and intentions that people must participate in solving environmental problems.
<b>SECTION B3</b>		
Methodological environmental skills.	(C6) Exercise in daily life individual behaviors that respect the environment, as well as participate in pro-environmental collective actions.	Behaviors of environmental citizenship. Waste separation actions for recycling. Responsible consumption behaviors. Resource conservation behaviors with personal economic benefit. Behaviors that reflect interest in nature. Environmental activism behaviors.
<b>SECTION C</b>		
Environmental perceptions in HEIs.	N/A	Opinion on the role of Professors for the incorporation of Environmental Education in Higher Education Institutions. Opinion on the role of Higher Education Institutions to implement curricular initiatives for environmental sustainability. Opinion on the role of Higher Education Institutions, as a context of informal learning for environmental sustainability.

Source: Álvarez-García, 2015.

Section A: Personal Information.

Section B: Environmental skills.

- Component B1: Cognitive environmental skills.
- Component B2: Attitudinal environmental skills.
- Component B3: Methodological environmental skills.

Section C: Environmental perceptions in Higher Education Institutions.

Table 1 shows the structure of the questionnaire adapted to the context of the case study, defining the three sections, the three groups of environmental competencies: cognitive, attitudinal, and methodological, the breakdown into the specific competencies to be developed in each group, and the topics to be evaluated that allow the understanding of the different aspects of each environmental competence.

The analysis of the data obtained belonging to environmental competencies (Section B) and environmental perceptions (Section C) required the use of descriptive statistics. Next, semi-structured interviews were applied to 3 expert professors / researchers in the environmental area to broaden the understanding of the results obtained, create discussion, and propose pertinent strategies that allow improving the development of environmental competencies at EPN.

### 3 Results

Fifty-one professors participated in the survey, 67% of whom were male and 82% of whom live in the city. On the other hand, 130 students participated, 61% of whom were female and 81% of whom lived in the city. Only 18% have taken an additional course to the subject of Ecology and Environment that is taught in all EPN majors.

#### 3.1 Assessment of cognitive environmental competencies

Environmental competence (C1): Table 2 shows the results that determine that professors have better cognitive environmental competences, since 92% have knowledge above the average level, while in students this percentage reaches 74%. Consequently, of the total number of respondents, 21% have a low level of environmental knowledge, 47% a medium level and 32% a high level.

#### 3.2 Assessment of attitudinal environmental competencies

To evaluate the topics corresponding to attitudinal competencies, the following assessment is proposed: range between 2 – 2.5 → Average, 2.5 – 3 → Good, 3 – 3.5 → Very Good and 3.5 – 4 → Excellent.

Table 2. Percentage of the level of environmental knowledge (C1) of the study sample in relation to each control group.

Knowledge level	Students	Professors	Total
Low	26%	8%	21%
Average	49%	43%	47%
High	25%	49%	32%
Average / 10	7.27 / 10	8.11 / 10	7.51 / 10

Source: Prepared by the authors.

Table 3. Evaluation of environmental competencies (C3), (C4) and (C5).

Environmental competence	Students	Professors	Total
Collective, individual, and governmental responsibility attitudes (C3).	3.3	3.45	3.34
Evaluate feelings and values related to the environment (C4).	3.28	3.19	3.26
Assess the motivation and intentions that people must participate in solving environmental problems (C5).	3.23	3.35	3.26
Average (C3), (C4) and (C5)	3.27	3.33	3.29

Source: Prepared by the authors.

Environmental Competence (C3) consists of three topics to evaluate, attitudes of collective, individual, and governmental responsibility. Collective responsibility attitudes get very good ratings for professors and good for students. Regarding the attitudes of individual responsibility, the professors have excellent attitudes, while the students have very good ones. In the attitudes of government responsibility, the professors are excellent, and the students have very good attitudes. Finally, the total average of environmental competence (C3) shows that in both control groups the respondents assume their responsibility in the actions that cause damage to the environment.

Environmental competence (C4): The averages of the competence (C4) regarding the feelings and values that are related to the environment are very good in both groups, affirming that the members of the EPN community understand value judgments about conserving the environment, which contributes to the well-being of ecosystems.

Environmental competence (C5): The averages of the competence (C5) regarding the motivation and intentions to participate in solving environmental problems in both groups are very good. Table 3 expands the values obtained when evaluating the environmental competencies (C3), (C4) and (C5).

#### 3.3 Assessment of methodological environmental competencies

Environmental competence (C6): to know if the respondents exercise individual behaviors respectful of the environment in their daily lives, 6 environmental behaviors

Table 4. Evaluation of environmental competence (C6).

Environmental competence (C6)	Students	Professors	Total
Behaviors of environmental citizenship.	2.57	2.68	2.6
Waste separation actions for recycling.	2.95	3.43	3.08
Responsible consumption behaviors.	3.33	3.62	3.41
Resource conservation behaviors with personal economic benefit.	3.59	3.67	3.61
Behaviors that reflect interest in nature.	2.76	3.02	2.83
Environmental activism behaviors.	2.17	2.2	2.19
Average (C6)	2.89	3.1	2.95

Source: Prepared by the authors.

Table 5.  
Evaluation of environmental perceptions in the EPN.

Environmental perceptions	Students	Professors
Opinion on the role of Professors for the incorporation of Environmental Education in HEIs.	3.24	3.47
Opinion on the role of HEIs to implement curricular initiatives for environmental sustainability.	3.45	3.45
Opinion on the role of HEIs as an informal learning context for environmental sustainability.	3.56	3.75

Source: Prepared by the authors.

are evaluated, which are: i) behaviors of environmental citizenship; ii) recycling waste separation actions; iii) responsible consumption behaviors; iv) resource conservation behaviors with personal economic benefit; v) behaviors that reflect interest in nature; and, vi) behaviors of environmental activism. The average assessment of these individual daily behaviors, evaluated in the competition (C6), is very good for the Professors, while it is good for the students. The information described above is broken down in Table 4.

### 3.4 Assessment of environmental perceptions in Higher Education Institutions

This section evaluated the opinion of the respondents about their perceptions regarding the role of Higher Education Institutions, their curricular plans, and Professors regarding Environmental Education issues. A 4-point Likert Scale was used to assess the level of agreement or disagreement about the perceptions.

Regarding the opinion on the role of Professors in incorporating Environmental Education in HEIs, those surveyed agree that it is necessary for Professors to include more environmental practices in their teaching and for students to have more environmental training. Regarding the opinion on the role of HEIs to implement curricular initiatives for environmental sustainability, both Professors and students agree that it is important to include more environmental issues in the educational system and to organize more relevant extracurricular activities that promote this purpose. Finally, the Polytechnic Community strongly agrees that it is necessary for HEIs to play a fundamental role in informal learning for sustainability, for example, promoting efficient waste separation processes and the non-use of one-use material for their events. on campus. The average values achieved are shown in Table 5.

## 4 Discussion

According to the results, the Cognitive Environmental Competencies for the members of the University Community averaged 3.01. On the other hand, attitudinal competencies, which refer to the favorable feelings, thoughts, and intentions of individuals regarding the environment, received the highest scores, averaging 3.29. Finally, the methodological competencies, which assess the exercise of respectful behavior towards the environment daily, obtained the lowest score of 2.95, as shown in Table 6.

Table 6.  
Evaluation of environmental competencies in the EPN.

	Cognitive Environmental Competencies (C1)	Attitudinal Environmental Competencies (C3), (C4) and (C5)	Methodological Environmental Competencies (C6)
Average	3.01	3.29	2.95

Source: Prepared by the authors.

Table 7.  
Strategies proposed regarding the group of cognitive environmental competencies.

Goal	Strategies
(C1) Nurture the level of environmental knowledge in Professors and students.	1. Motivate self-learning.
	2. Implement comprehensive and degree projects related to environmental sustainability.
	3. Offer MOOC courses (Massive Open Online Course) related to Environmental Education.
	4. Offer at least one additional elective subject related to aspects of environmental sustainability, so knowledge of the Ecology and Environment can be increased and complemented.
	5. Promote dissemination spaces, scientific cafes, and academic presentations regarding environmental issues.

Source: Prepared by the authors.

Considering the results obtained, objectives and strategies that allow the development, maintenance and/or improvement of each one of the environmental competences of the study context have been outlined. Being in an academic context, it was found that cognitive skills are significant, since approximately 80% of respondents have environmental knowledge between medium and high. However, they are not outstanding either in professors or students. Consequently, it is necessary to propose pertinent strategies. Table 7 shows the strategies proposed with the aim of nurturing the level of environmental knowledge in EPN professors and students.

The group of attitudinal environmental competencies obtained the highest average value; therefore, it is concluded that the feelings, thoughts, and intentions (attitudes) of EPN members are favorable regarding the environment. In this competence, five environmental attitudes were evaluated, objectives were set, and strategies were outlined to maintain and improve these attitudes.

Of the five topics, the Attitudes of collective responsibility are the ones that had the lowest average value; consequently, care is required in this area, so it is necessary to form pro-environmental groups in the university context that involve more professors and students. Favorable attitudes on the part of the teaching staff constitute a necessary, but not sufficient condition for the transition of environmental competences [27]. Table 8 shows the strategies proposed to improve attitudinal skills in EPN professors and students.

Table 8. Strategies proposed regarding the group of attitudinal environmental competencies.

Environmental attitudes	Goal	Strategies
(C3) Collective responsibility attitudes.	Participate collectively in environmental initiatives.	1. Encourage creation of student associations with high environmental values.
		2. Promote participation in collective actions promoted by neighborhood associations or environmental movements.
(C3) Individual responsibility attitudes.	Participate individually in initiatives and in the resolution of environmental problems.	3. Encourage students and professors to participate in solving environmental problems through comprehensive and degree projects.
		4. Require EPN authorities to establish environmental sustainability plans and regulations.
(C3) Government responsibility attitudes.	Encourage citizens to become actively involved with regulations and laws regarding the environment.	5. Carry out talks and scientific dissemination on a regular basis to raise awareness regarding the environment.
(C4) Feelings and values related to the environment.	Strengthen respect and equity with the environment.	6. Carry out awareness campaigns regarding human interference in ecosystems, their impacts and possible solution strategies.
		7. Motivate students and professors to participate in research projects, technology transfer and links with society to contribute to environmental sustainability.
(C5) Motivation in intentions to participate in solving environmental problems.	Motivate people to get involved and participate in solving environmental problems.	

Source: Prepared by the authors.

The group of methodological environmental competencies is made up of six topics, shown in Table 4. The two environmental behaviors with the lowest ratings are environmental citizenship and environmental activism. The results show that collective attitudes and behaviors are the least valued and performed. Consequently, the university and other groups play a central role in promoting pro-environmental practices. To improve environmental behaviors at EPN, strategies in Table 9 have been proposed.

The literature says that environmental education improves environmental knowledge, attitudes, intentions, and behavior [28]. Emphasizing that solid teacher training contributes to the comprehensive education of students, and it can be a transcendental tool in solving environmental problems [29]. It is important to adopt appropriate teaching

Table 9. Strategies proposed regarding the group of methodological environmental competencies.

Environmental behaviors	Goal	Strategies
Behaviors of environmental citizenship.	Promote common collective pro-environmental work.	1. Carry out campaigns, solidarity meetings or common work in the Polytechnic Campus and surrounding neighborhoods.
		2. Demand that EPN authorities improve on campus comprehensive management of waste separation.
Waste separation actions for recycling.	Improve waste separation management.	3. Encourage reuse of paper, plastic covers, cardboard, and others on campus.
Responsible consumption behaviors.	Strengthen responsible consumption behaviors.	4. Promote the use of respectful and ecological products on campus.
		5. Promote the responsible use of lights, elevators, and water on campus.
(C6) Resource conservation behaviors with personal economic benefit.	Promote critical thinking that places the environmental dimension above the economic one.	6. Carry out talks and scientific dissemination to create environmental awareness and criteria.
		7. Put up striking and interesting posters regarding the environment on billboards in the different departments.
Behaviors that reflect interest in nature.	Develop genuine interest in environmental issues.	8. Encourage the participation of students and professors in campaigns, solidarity meetings or common work on campus and surrounding neighborhoods.
Environmental activism behaviors.	Develop participatory interest in environmental activities.	

Source: Prepared by the authors.

strategies such as project method, problem solving method, seminars and workshops to protect the environment [30].

Thus, it is necessary to work on the development of environmental competencies of Higher Education Institutions, involving the entire community and even transforming university curricula by incorporating values, content, and skills necessary for sustainability. Teacher training policies are necessary to make effective environmental education, in addition, changes can be an interesting differentiating factor for certain universities [31].

Finally, strategies proposed must be part of a management model that allows the organization's activities and processes to be systematically controlled, with the participation and involvement of all its collaborators, emphasizing that not only is their aptitude important, but also their attitude.

## 5 Conclusions

The research helps identify and assess the environmental competencies that professors and students of Higher Education Institutions and the National Polytechnic School should possess: i) Cognitive environmental competencies or environmental knowledge; ii) Attitudinal environmental competencies related to feelings, values and intentions and; iii) Methodological environmental competences referring to the daily behaviors exercised by individuals regarding the environment. The results determined that the methodological competences obtained a lower value with regard to the cognitive and attitudinal ones, since these involve profound changes in lifestyles that enact a responsible daily action with the environment. Thus, firm, and repeated strategies and actions are needed to increase these skills.

The analysis made it possible to determine that the professors obtained higher averages in the three types of environmental competencies compared to the students. This may be due to factors such as: i) education level; ii) age; iii) many are heads of households and are thoughtful about household expenses; iv) lifestyles; v) attitudes and values with which they have grown, among others. However, aspects such as education are not decisive since individuals with a high level of knowledge do not feel empathy for nature and do not exercise favorable behavior towards the environment and vice versa.

The issues with the lowest evaluation are those of attitude and collective behavior, provoking the reflection that individual and small actions count in aspects of environmental sustainability. However, complex problems require coordinated solutions at all levels. Therefore, educational spaces play a fundamental role in instructing and transmitting responsible attitudes and practices towards the environment towards society.

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