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How Do Children Perceive the Biodiversity of Their nearby Environment: An Analysis of Drawings

Hortensia Morón-Monge [1,*], Soraya Hamed [1] and María del Carmen Morón Monge [2]

[1] Departamento de Didáctica de las CC. Experimentales y Sociales, Universidad de Sevilla, 41013 Sevilla, Spain; sha@us.es
[2] Departamento de Didácticas Integradas, Universidad de Huelva, 21007 Huelva, Spain; mcarmen.moron@dhis2.uhu.es
* Correspondence: hmoron@us.es

Abstract: The research indicates the importance of learning about our natural environment from an early age to train scientifically literate and environmentally responsible citizens. The purpose of this study was to investigate the perceptions of a group of 120 primary school children regarding the biodiversity of their nearby environment (Andalusia, Spain) based on their drawings. For this, we used a qualitative methodology that focused on the analysis of the content. We analyzed the content of each drawing, complemented with written questions and an interview. The different environmental elements (natural, geological, and anthropic) of the children's drawings were identified and analyzed. The results show how children perceive the biodiversity (plants and animals) of their nearby environment and their low knowledge of the concept of the environment as a system. Likewise, this study allowed for the definition of a series of emerging categories as an instrument of analysis that will serve as the basis for the design of appropriate strategies to improve initial teacher training in regard to science education.

Keywords: biodiversity; perceptions; science education; primary education; drawing; teacher training

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1. Introduction

We live in a complex and changing world marked by great problems and socio-environmental inequalities. As such, the population must be educated to face new socio-scientific issues [1,2]. The recent global health crisis of COVID-19, the climate emergency, and biodiversity loss are only some examples of the consequences of environmental imbalance and socio-environmental problems in the world today [3,4].

The biodiversity concept is a complex term that has become widely used since first being coined in 1986 [5]. According to the International Convention on Biological Diversity (CBD) of 1993 [6], biodiversity is understood as all living beings that populate the Earth, as a result of billions of years of evolution, together with the influence of humans. Biodiversity is defined as the specific properties of a given geographical area, structured in elements and levels (genetic, taxonomic, and ecosystem diversity), with relationships between the components of the system (biotic and abiotic), and where human beings have acquired increasing relevance [5]. However, this conceptualization is being broadened and becoming more complex, considering the social, ethical, moral, economic, and cultural aspects [7].

Spain is the country with the highest biodiversity in Europe. The southern region, Andalusia (Figure 1), has the highest concentration of biodiversity in Spain. Andalusia is known for being a biodiversity hotspot, and its forests represent one of the 25 biodiversity hotspots identified across the world [8]. This is because Andalusia is a "biogeographic bridge" between Europe and Africa [9]. There are different types and representations of ecosystems, including big mountains (Sierra de Nevada, Granada), deserts (Desert of Tabernas, Almería), long, wild beaches (Dune of Bolonia, Cádiz), and well-known marshes (Marshes of Odiel, Huelva). These different ecosystems are important not only due to their

diversity, but also for different ecosystem functions such as their importance for migratory birds, such as in Doñana (National Park) or Laguna Fuente de Piedra (Natural Park).



Figure 1. The National Parks of Andalusia (source: https://www.absoluteaxarquia.com/national-parks-of-andalucia, accessed on 1 March 2021).

Therefore, it is necessary to develop an educational model in our region that allows us to equip people with the tools to understand their nearby environment and its biodiversity. Some studies have pointed out the current challenges of biodiversity education [10,11]. Broadly speaking, both studies agree on the importance of developing scientific literacy and environmentally responsible citizens for sustainable development [12]. In particular, today's children are potential agents for the pro-environmental change, as UNESCO (the United Nations Educational, Scientific and Cultural Organization) asserts: "*Education can empower children, youth, and adults to take action at a local, national and global level and cooperate in meeting current and emerging challenges in an increasingly interconnected world*" [8]. From a very young age, children develop their initial understanding of the concepts and ideas of science through their daily interactions with the natural world [13–15]. This interaction implies a great curiosity for their immediate surroundings, asking questions and exploring through senses [15–18]. One of the relevant aspects in this regard is the convenience of promoting educational interventions that provide learning situations in order to examine children's ideas on socio-scientific issues [12].

Outdoor education, in the context of science education, allows us to work on these issues, where children can learn in a contextualized way in their environment, explore, develop sustainable and responsible environmental attitudes, etc. [3]. In recent years, there has been great interest in this topic in the science education research [3,19–25]. Moreover, outdoor education during the COVID-19 pandemic may be a positive way in which to reduce the spread of the virus in schools.

Bearing in mind this background, this study took place in Seville, the capital of Andalusia. We focused on primary-age children to gauge their perceptions about the biodiversity of their nearby environment. Our target was to inquire about children's biodiversity perception from their drawings to understand their learning difficulties and educational needs with regard to science education and improve educational programs at this educational stage. In particular, in terms of science education and teacher training, we want to emphasize the value of the development of scientific skills such as observation when learned in context, while also promoting outdoor education to prospective primary school teachers.

Drawings are a data collection tool through which we can understand children's perceptions, experiences, and mental images via their creative and emotional expression [26–32]. Asking children for drawings reduces the tension of the activity in formal educational

contexts, since it is not perceived as a regular test, inviting even the shyest to participate [26]. Likewise, it allows us to overcome the possible difficulties of written expression.

The study of perceptions is the first step to understanding conceptions. Through perceptions, it is possible to explore children's concerns, knowledge, and/or the sources of information they can handle [33]. In this sense, environmental perception is understood as that which allows us to learn about our immediate physical environment through the senses, develop different attitudes towards the environment, and show our own favorable or unfavorable feelings towards it [31,34]. Environmental perception allows us to know how each person looks at the environment that surrounds him/her according to his/her experience.

There is abundant and diverse literature on the environmental perceptions of students who use drawings as a source of information from different perspectives [26,28,31,35–41]. Some previous studies show children's egocentric conception of the environment [29] and their difficulty in recognizing the main environmental relations. In relation to this, animism or anthropomorphism, assigning human qualities to inanimate objects [42], is a common feature that appears in the drawings of children. Beltran [41] showed the scarcity (quantity and variety) of natural elements (flora and fauna) that appear in kindergarten children's drawings. In relation to geological elements—e.g., soil, rocks, and minerals—they are usually the elements that young people ascribe less relevance to [35]. In terms of geography, Terrado et al., Capel, and Beltran Sierra [36,38,41] showed us how drawings represent the space-time notions that children are capable of perceiving, which are extremely important aspects from the perspective of the construction of one's conception of the environment.

Few studies of science education deal with the two key aspects that are considered here: children's perceptions of biodiversity and their implications for teacher training. One of the most relevant aspects of this study is the biogeographic context in which it was carried out since Andalusia is rich in biodiversity and it is necessary to investigate the perceptions of children to improve their view of the environment and thus be able to conserve the biodiversity of this region. Located in the south of Spain, it presents a multitude of teaching opportunities for science teaching if teachers know how to use it for fieldtrips.

Similar studies have been carried out in the Sonora Desert (Mexico) with kindergarten children [41]; in Germany with teenagers; and in Spain, comparing children's views (children who live in rural areas vs. children who live in coastal areas) [30]. However, there are no previous studies that focus on this Spanish region and few that look at Andalusia from a science education point of view.

Finally, examining children's perceptions of biodiversity allows us to approach their conceptions of the environment [3,33,43]. Therefore, this work should be understood as the first approximation of the perceptions of biodiversity of primary school children. With these preliminary findings, in terms of science education, we can improve teacher training.

2. Spanish Curriculum Background: Biodiversity in Primary School and Science Education

The notion of biodiversity and the problems of its conservation constitute one of the great challenges in the school environment. It is a difficult construct to teach in the classroom due to its complexity and high degree of abstraction [3,40–42]. However, in science education, biodiversity is an emergent topic and there are few studies on it [5,44]. Thus, we briefly describe how this topic appears in the Spanish curriculum.

Primary education, in the whole of Spain, is divided into six grades for children aged from 6 to 12. The Spanish state establishes the objective of a basic, open, and flexible general curriculum. In Spain, the current way biodiversity is treated in the official curriculum and school textbooks proposes a partial form of content sequencing [5,45]. In the most recent Spanish educational laws, *Ley Orgánica de Educación* [46] and *Ley Orgánica para la mejora de la calidad educative* [47], the concept of biodiversity is absent and is only mentioned under the term "biological diversity". This term is more restrictive and limited than simply "biodiversity" [5].

Every autonomous regional administration develops their frameworks, and schools develop their individual curricula accordingly. This is important because every autonomous regional administration has different historical, sociocultural, and natural contexts [48]. In Andalusia, DECREE 97/2015 [49] set its educational curriculum for primary education. The Andalusian curriculum includes the importance of nature conservation, with topics such as flora and fauna, living beings and the ecosystem, renewable energies, and environmental pollution. This conservation perspective is observed throughout the entire curriculum (with objectives, competencies, evaluation criteria, and content). However, as in state law, there are no explicit mentions of the term biodiversity. On the contrary, throughout the entire text, the term environmental heritage is used to refer to the bio- and geodiversity of Andalusia, as something typical and characteristic of this region from Objective 5: "*Know and value the heritage of Andalusia and actively contribute to its conservation and improvement*". This objective is later specified in different evaluation criteria (e.g., Evaluation Criterion 2.4: "*Identify and critically analyze the actions that human beings carry out in their daily life, in the face of natural resources, energy sources, respect for other living beings, (. . .) promoting individual and collective behaviors that favor good conservation of the environment (. . .)*" and Evaluation Criterion 3.3 *"Know and classify the components of an ecosystem according to their characteristics (. . .) establishing relationships between them to ensure the species and balance the ecosystems, (. . .) and in the conservation of ecosystems")*.

At the regional level, a greater representation of biodiversity appears from its treatment at a functional level. However, biodiversity is addressed at neither the species nor the genetic level [5]. As Escobero Rodríguez [5] pointed out, the treatment of biodiversity in the curriculum both at the national level and in Andalusia is still incomplete and limited.

3. Materials and Methods

This study analyzed how children perceive the biodiversity of their nearby environment. Therefore, our main research question was as follows: What perceptions of the nearby environment do primary school children have?

For this, the different environmental elements (biological, geological, and anthropic) that influence children's perceptions were examined. Likewise, when dealing with this question, we could assess children's conceptions of the environment, their geographical and cartographic knowledge, and even their artistic abilities. However, this study focused on analyzing their knowledge in relation to the environment and biodiversity based on their drawings.

3.1. Participants and Socio-Cultural Context of the Schools

The sociocultural and geographical characteristics of both educational centers and the study participants are described to contextualize the study results. As indicated, this research was carried out with 120 children in the sixth grade of primary education, made up of 72 boys and 48 girls, aged between 10 and 11 years old.

The participants were children who attend two public schools. Both schools are located on the outskirts of the old town of the capital city of Seville, in the southern area. The schools are adjacent to large green spaces, such as Guadaira Park (approximately 60 ha), which was inaugurated in 2013. This space is an old and abandoned riverbed of the Guadaira River that has been regenerated. Now, the park is in the process of expansion as it intends to connect different areas of the city through a metropolitan green corridor. As such, this space could become a new green lung for the city. Although both schools have modest infrastructures and resources (as do most Spanish public schools), they both have a good academic reputation. The students' socioeconomic and cultural circumstances are medium–high and are very similar in both schools.

3.2. Data Sources and Procedure

The data collection process, in relation to ethical considerations and the main characteristics of the data collection instrument (a questionnaire), is described in this section.

Before collecting data in both schools, we considered a series of ethical principles. Ethical permissions were granted, and, in each school, the required permissions were obtained (from administrators, teachers, and families). The children involved were considered competent research subjects capable of agreeing or refusing to participate in the study. Moreover, pseudonyms are used throughout the paper. The researcher was fully aware of the needs and development of the children and worked with classroom teachers in collaboration. The drawings were produced during whole-class sessions, with each session lasting 30–45 min on average. In total, the data collection process took about 1 h per class.

Regarding the data collection instrument, Table 1 describes the main characteristics and objectives of the questionnaire and the interview. The process was guided by three questions: two closed questions and one open. The last question (open question) was subdivided in two sub-questions.

Table 1. Characteristics questionnaire and interview.

Question		Type
(1) Frequency: *Do you usually visit Guadaira Park?*		Closed and dichotomous question (Yes/Not) with four options: • No, I don't like parks. • No, I don't usually visit it. • Yes, once per week. • Yes, more than once a week
(2) Frequency: *How many times have you visited nature (the beach, countryside, mountains, etc.) in the last month?*		Closed question with four options: • Never • Once • Two to three times • More than three times
(3) Preferences: *Which is your favorite natural place?*	(3a) Write a story	Open question
	(3b) Draw a picture	Open question

The objective of the first question (*Do you usually visit Guadaira Park?*) was to know the frequency with which the children in this neighborhood of the city visit and make use of green spaces close to them, to which they do not have to travel long distances nor depend on transport or adults to be able to access them. Likewise, this question helped us to compare these answers with those obtained in regard to other natural spaces that students may have a greater preference for but less opportunities to visit and enjoy.

The objective of the second question (*How many times have you visited nature (the beach, countryside, mountains, etc.) in the last month?*) was to understand the contact the children have with their nearby environment.

The third question (*Which is your favorite natural place?*) was an open question made up of two parts. In the first (Part 3a), they must answer in writing what their preferred natural space is and, in the second part, draw a picture of it (Part 3b).

3.3. Data Analysis

Our sources of information were children's drawings and written narratives [39], from a questionnaire with open and closed questions. To interpret the drawings and the narrated responses of the students, we conducted a qualitative investigation through content analysis [50,51]. This allowed us to characterize, in a systematic and verifiable way the students' perceptions with the generation of conceptual categories in order to create or test theories [50]. This is an inductive and evolving process [51], in which the categories emerging from the data are based on the most frequent student answers [12,52,53]. In

this sense, the following procedure was followed: (a) incorporation of the responses into the ATLAS.ti software (v. 8); (b) identification of text segments and elements of the drawings in relation to meanings (units of analysis) related to the ecosystem, e.g., biological, geological, anthropic, and geographical (location and representation), among other elements, such as animism or anthropomorphism (Piaget [54], whose studies are very influential in contemporary education, saw animism as faulty reasoning arising from children's egocentricity [55,56]); (c) units of analysis that shared the same characteristics were grouped into the same conceptual category; and (d) elements and text segments were identified by assigning a code. The definition of each code corresponds to that of the emerging category and subcategory (see Table 2). To address validity and reliability, the categories were inferred in contrast to theory [3,29,33,36], since the specific units of analysis are less inferential [50]. In addition, throughout the data analysis process, the information was repeatedly reviewed in order to discriminate the significant segments through a process of assessment inter-judgment [12,57]. Four researchers participated during the analysis process, with two of them (the authors) analyzing each of the drawings. Afterwards, crossover analyses were carried out with two other researchers, negotiating the discrepancies and emerging categories (in this way, an agreement of up to 80% was obtained). The drawings that generated doubts for one couple were discussed with the other and agreements were reached. The controversial cases were subjected to further discussion until a majority consensus was reached (95%). Finally, the number of subjects found in each category were quantified.

Table 2. Categories-descriptors instrument.

Categories	Sub-Categories		Descriptors
I. Typology of environment: level of environmental alteration	*Anthropized environment*		Urban parks, zoos, aquariums, urban gardens, in which artificial elements predominate.
	Mixed	Rural	Fields, agricultural and/or livestock areas, pasture systems, reservoirs, that combine natural elements and others typical of human agricultural and/or livestock activity.
		Coast	Beaches, estuaries, coastal cliffs, etc., with infrastructure (access and/or leisure) or close to urban centers.
	Natural environment		Mountain areas, valleys, lagoons, marshes, wooded areas, and other areas far from urban centers and/or with little alteration, whether they are protected at the legislative level.

Table 2. *Cont.*

Categories	Sub-Categories		Descriptors
II. Environment Descriptors: main characteristics of the drawings	*Animism*		Assigning human qualities to inanimate objects. For example, the Sun, the Moon, etc., are represented with smiling faces/animals or plants have anthropomorphic forms.
	Elements that predominate	*Anthropic*	Elements of human origin, including whether they are associated with economic activities of an industrial, agricultural (wells and fences, etc.), recreational (camping), urban, etc. nature.
		Biological Fauna	Natural animal elements of three types: wild, domestic, and fantastical or mythological.
		Biological Flora	Natural plant elements of three types: herbaceous, shrubby and arboreal.
		Geological	Geological elements from landforms to geological elements, such as mountain slopes, valleys, beaches, sheets of water, rocks, etc.
	Contextualization: Location and representation		The elements represented respond to geographical and temporal issues. There is integration between the elements and logic in their spatial relationships. The drawing is contextualized (C): in an urban park, as a general context, swings, fountains, children playing, etc., are drawn. On the contrary, the drawing is decontextualized (DC): for example, a child has drawn a mountain where there are sharks or natural elements that do not correspond to the ecosystem of the place at a spatial or temporal level.

Bearing in mind these main elements, we designed an analysis categories instrument (Table 2). This instrument was made up of two main categories and subcategories.

Category I (typology of environment) groups the different spaces into three typologies, from a greater degree of alteration to a lesser degree: anthropized spaces, mixed spaces (rural or coastal areas), and natural spaces. We considered the coastal environment within the classification of mixed spaces for biological and human reasons—the first because it is an ecotone and a space rich in diversity, giving it great economic interest. For this reason, it is usually a highly exploited space (for fishing, tourism, port transport, etc.) with a greater or lesser level of intensity by humans. The second reason was related to the preferences of humans for beaches as places of leisure and recreation, therefore leading to infrastructure and facilities being developed there [58].

Category II (environment descriptors) was composed of three sub-categories and descriptors, in addition to offering some examples: animism, elements that predominate (anthropic, biological, and geological), and contextualization. Within this last sub-category, contextualization, there are two possibilities, *contextualized* or *decontextualized*, that are used to refer to aspects of localization and representation from a geographical point of view [36,38,41].

4. Results

Question 1: *Do you usually visit Guadaira Park?* As shown in Figure 2, half of the students do not usually visit the park, while six students claim not to like parks. In total, 30% of the students visit once per week and just 15% more than once a week.

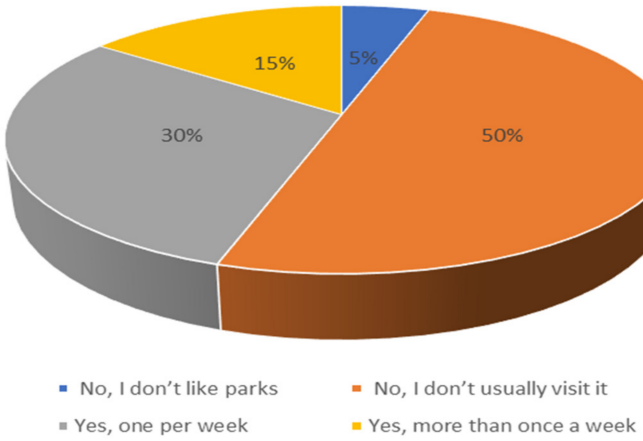


Figure 2. Frequency: Do you usually visit Guadaira Park?

Question 2: *How many times have you visited nature (the beach, countryside, mountains, etc.) in the last month?* As shown in Figure 3, approximately 30% barely visit their nearby environment, 65% usually visit natural spaces between two and three times a month, and only 5% have greater contact with the environment.

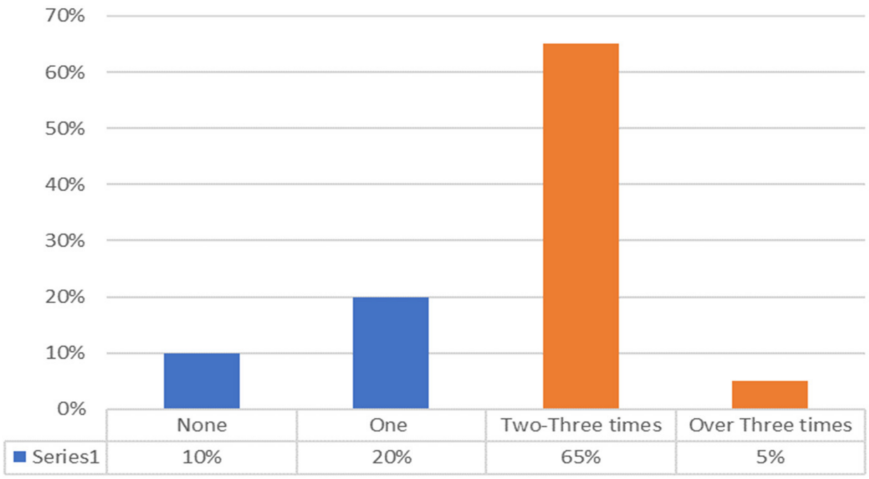


Figure 3. Frequency: How many times have you visited nature (the beach, countryside, mountains, etc.) in the last month?

Question 3a. Preferences: *Which is your favorite natural place?* As this is an open question, a great variety of responses was collected, in which each child offered more than one answer, all of which were classified as being in Category I. In addition, the results were sub-classified when children differentiated between *specific* or geographically located spaces (my uncle's field, Doñana National Park, or a specific rural town) and *general* spaces/spaces without a geographic reference (nature, mountain, field, zoo, etc.).

Table 3 shows the spaces preferred by the children: 43% correspond to mixed environments, 13% consider a rural environment (the countryside or a town), and 31% indicate a coastal environment. Anthropic and natural environments reach the same percentages (28.5%). When distinguishing between specific and general responses, it is striking that, for rural areas, the responses provided are mostly related to specific places (see Figure 4).

Table 3. Results for Category I. Narrative text.

Naturalness Level		General Environment (n)	Specific Environment (n)	Total Frequency	% Total
Anthropized environment		24	10	34	**28.5**
Mixed	rural	9	6	15	**43**
	coast	26	11	37	**25**
Natural environment		24	10	34	**28.5**
TOTAL		83	37	120	**100**

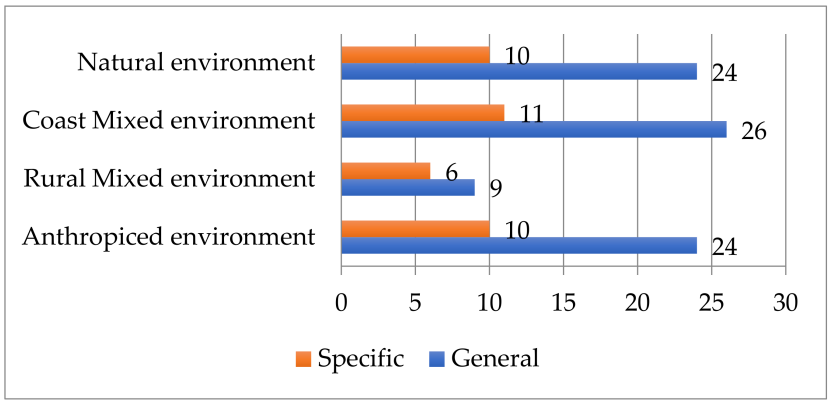


Figure 4. Which is your favorite natural place?

Question 3b: Preferences: *Draw your favorite natural place*. The 120 drawings obtained from this open question were analyzed.

First, the drawings were classified according to Category I. Moreover, we included a new sub-category, "other", for drawings that did not correspond to the previously described characteristics, e.g., where information is insufficient or representations are fantastical because of children's creativity (see Figure 5). Most of the drawings corresponded to a mixed environment (52.5%), either coastal or rural. Only six drawings were classified as anthropized environment that corresponds to an urban park. The natural environment was the second most drawn environment, corresponding to landscapes of mountains and rivers. In total, 14% of the drawings were classified as "other" because they provided little information or were fantastical.

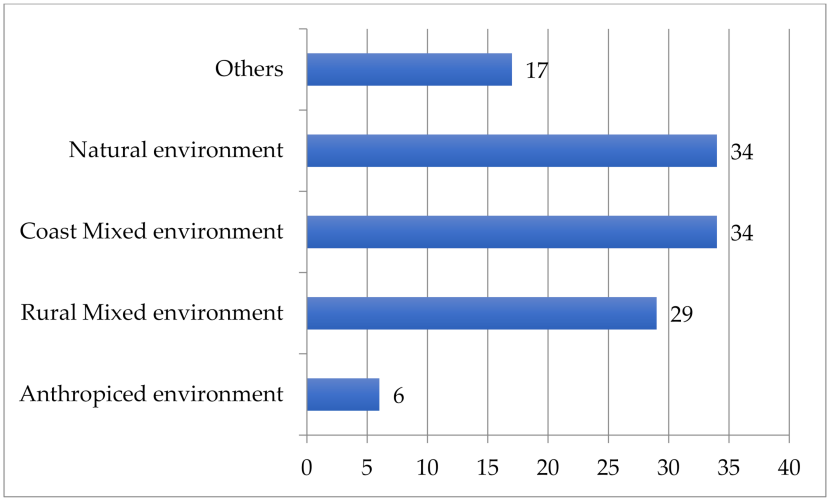


Figure 5. Draw your favorite natural place.

Second, the drawings were analyzed starting from Category II, with special attention paid to the three sub-categories:

(I) Animism: In total, 90% of drawings corresponded to a real place, compared to 10% that represented animated elements of place (Figures 6 and 7), where it was observed that the Sun was given human properties.

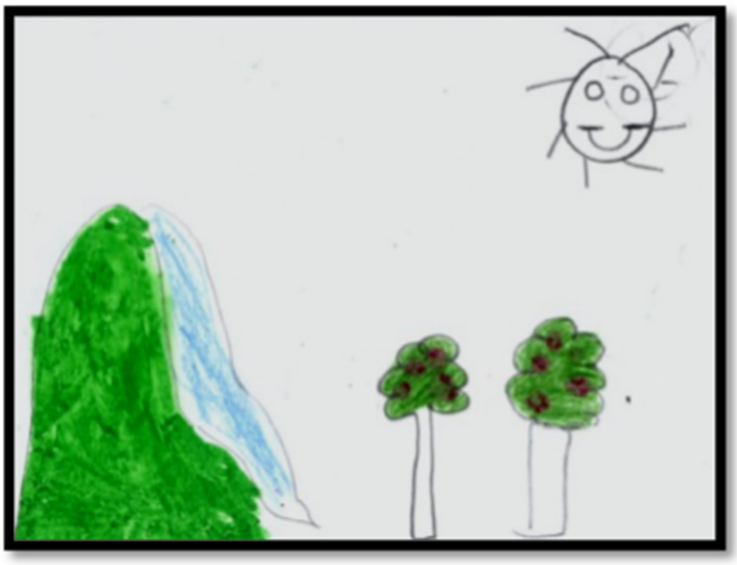


Figure 6. Example animism.



Figure 7. Example animism.

(II) Elements that predominate: Table 4 lists the different elements represented in the drawings by typology. In a single drawing, we can find more than one type of element and subtype. Anthropic elements are the most represented in the drawings (33%), the majority of which usually correspond to rural elements, as seen in the example in Figure 7. Characteristic anthropic elements of infrastructures associated with recreation and leisure on the beach are also represented. In "others", we included infrastructures or items associated with leisure, such as tents, tablecloths, tables, chairs, etc., (see Figure 8a). No urban or industrial elements were represented in any of the analyzed drawings.

Table 4. Results Category II: Sub-category "Elements".

Elements that Predominate		General: Pictures Quantity	List of Type of Elements
A. Anthropic		33%	• Rural elements: country houses, fences, country roads, etc. • Coast elements: umbrellas, boats, towels, floats, etc. • Others (entertaining): tents, picnic utensils,
B. Biological	*Fauna*	19%	• Domestics: horses, dogs, and cats • Insects: ants • Wilds: snakes, elephants, birds, fishes, and sharks. • Fantastical/mythological (e.g., dragons and unicorns).
	Flora	31%	• Trees: fruit trees, fir trees, and palms. • Shrubs. • Herbaceous or flowers.
C. Geological		17%	• Mountains • Rivers and lagoon or other types. • Volcanos

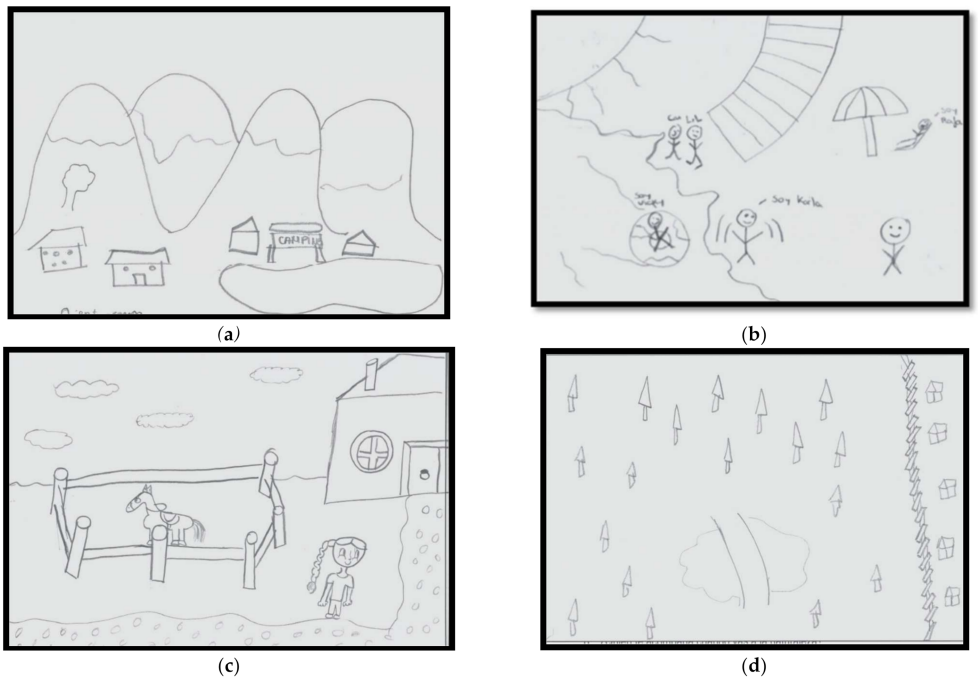


Figure 8. Example geology element (**a**); example coastal element (**b**); example fauna element (**c**); and example flora element (**d**).

On the contrary, geological elements, such as mountainous landforms, rivers and lakes, and valleys, as shown in Figures 6 and 8a, are the least represented (17%). Within this type, sheets of water (rivers and lakes) are most often represented. Fauna also appear poorly represented (19%) in terms of quantity and diversity. Domestic animals are as important as the representation of mythological or fantasy animals (Figure 9), such as unicorns and dragons. Those most represented are the most common wild animals (birds and fish) as well as some snakes, elephants, or even sharks. Smaller animals, such as insects, are underrepresented (an ant appears in one drawing). Flora are the second most represented element (31%), although, as with fauna, the diversity of plants that are represented is scarce. Trees are broadly presented in the drawings, with a palm tree, fir trees, and fruit trees, which appear in the most drawings (orange or apple trees), as shown in Figures 6 and 8d.

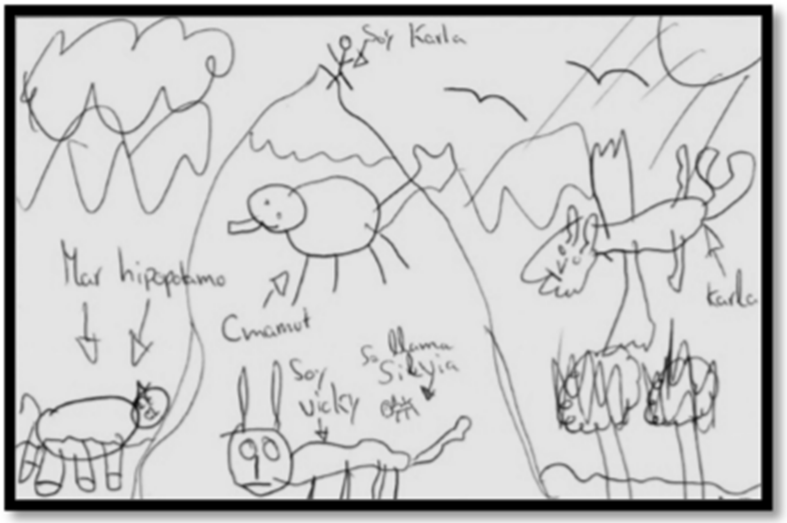


Figure 9. Example fantastical environment.

III. Contextualization: 85% of the drawings are contextualized in terms of location and spatiotemporal geographical representation. Only 15% of children drew decontextualized images (fantasy or with little information; see Figures 8d and 9). In Figure 10, in addition to fantastical animals (dragon), elements of place with no apparent biological and/or geological meaning are observed. In Figure 10, hardly any information is offered from the simple representation of the elements, the type of place represented, or its most characteristic elements.

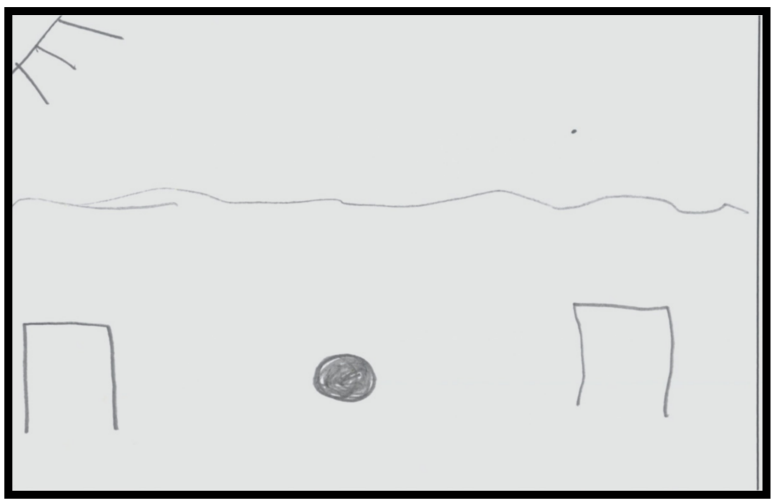


Figure 10. Example decontextualized environment.

5. Discussion

In relation to Question 1, the frequency with which the children visit the park in their neighborhood during the week, we were struck by the fact that more than half admitted that they do not usually visit the place, despite it being an accessible, safe, wide site with a diversity of opportunities for leisure. In addition, as described above, it is a newly opened and expanding place, so it generates greater attraction for children due to its novelty. Similarly, the good weather conditions in southern Spain, where this research was framed, invite outdoor activities in parks and green areas. These results also indicate that the teachers at these schools carry out few outdoor activities in the park. These data correspond to other similar investigations for the same geographic context. At the secondary education level in Spain, only a third of teachers carry out fieldtrips [59], while other teachers declare that, despite knowing the benefits of outdoor learning, they do not usually utilize fieldtrips [41,60–62].

Comparing these data with Question 2, in which the same question was formulated, but expanded to other natural spaces that may be more distant from their neighborhood, it was observed that the vast majority (75%) visit other natural spaces between two and three times a month (some even more than three times). Comparatively, these results are better than those regarding the frequency with which children visit Guadaira Park weekly. Despite Guadaira Park being a nearby place to which children have easy access due to its proximity, the students visit more distant natural spaces. We suppose that they visit these more distant environments with their relatives during the weekend, being an obligatory activity, unlike visiting the park, which they can do on a voluntary basis.

In relation to the open questions and their analysis (Questions 3a and 3b), the majority of the main environmental elements represented in the drawings (Question 3.b) were understandable. However, the rest of the drawings produced were somewhat abstract in the opinions of the researchers, so the oral and written descriptions (Question 3.a) of the participants were important for their categorization. Similar circumstances were found in [37], during the research and analysis of children's drawings of desert environments.

Question 3, being an open question, offered us a great deal of varied information that allowed us to know not only what type of environment is preferred by children, but also their knowledge of bio- and geodiversity. According to the answers collected in Question 3a, the preferred environment for children (43%) is one with a mixed level of disturbance, such as rural and coastal areas. In rural areas, it is striking that their answers are more specific, that is, they specify geographical aspects related to their location: "my uncle's field" or "village X". Therefore, children may prefer these places not due to aesthetic (beauty of the place) or biological (diversity of plants and animals) reasons, but due to emotional, socio-cultural, and heritage- or identity-related reasons.

This corresponds to the perspective promoted by the Andalusian educational curriculum (DECREE 97/2015) of treating the environment and its biodiversity from a heritage point of view. From the perspective of heritage education, the individual establishes identity relationships with their natural environment, and, consequently, the individual gives new value and greater importance to said environment on an emotional level [63]. Anthropic environments, such as urban parks and zoos, have the same level of interest for children as environments with a higher level of naturalness (forests, protected areas, etc.). It is worth pointing out that, although mixed media are preferred by children, in none of the representations do elements or signs appear that show direct environmental contamination (waste, air pollution, water, etc.). As such, it might be concluded that children prefer clean environments [64]. However, we did observe a certain degree of alteration of the natural environment by reforestation monocultures and/or agricultural fields, as shown in some of the drawings.

In relation to specific environmental elements such as flora and fauna, we obtained the following results. In most of the drawings, trees appear, but shrubs or herbaceous plants are hardly seen. The trees represented, after oral clarifications by the students, indicate that the majority correspond to fruit trees, such as apple or orange trees. This

distinction between fruit trees is important, since the orange tree is a characteristic tree of this region of Andalusia and can be found close to children in both rural and urban areas. Other species of trees identified are palm trees and pines/firs due to their conical representation, although the children generically called them all "pines". Thus, children are hardly able to distinguish between the most characteristic plant elements of their environment. More surprising is that the same thing happens with fauna. Wild animals are the most represented, with many of them being exotic or non-autochthonous. These results correspond to other studies with children, such as that of Beltran Sierra [41]. In particular, the most identified animals are fish and birds, perhaps because drawing them is easier and they can be represented in many ways. This is also the case with the smaller herbaceous vegetation (flowers, small plants, and herbs), which go unnoticed in children's drawings. Moreover, smaller animals, such as insects, including everyday creatures such as butterflies and ants, are practically unrepresented. Therefore, in the children's drawings, biological, plant and animal elements are not abundant in terms of number or variety.

In relation to the geological elements and their main features, these are the ones that acquire the least relevance in the representations. The common elements of the landscapes the children draw include water, in the form of rivers, ponds, or the sea (in the case of coastal representations). Children perceive rocks as the "floor" for life and buildings to be placed on top of [35]. This is not surprising since, as Martínez-Peña and Gil-Quílez [35] pointed out, the subject of geology has been losing representation in the educational curriculum in Spain in recent years, as in many other countries. Another aspect to highlight is that exotic and even fantastical places are also preferred by children. These drawings convey the expression of a perceptual space frequently modified by the imagination [36]. This may be because drawing is an instrument of artistic and creative expression, so children are able to express themselves freely [29].

In general, these results may be viewed as disappointing from the point of view of the richness in terms of bio- and geodiversity in the places where these children live. As previously described, Andalusia is a biodiversity hotspot.

Finally, if we compare the results of what the children wrote about the natural environments they prefer (Question 3a) with the one they later drew (Figure 11), many correspondences are observed. The preferred environment that they drew usually corresponds (52.2%) to a mixed medium (rural or coastal) and, in the written answers, their preferred environment corresponds with the natural environment (43%), while a higher level of naturalness is found in responses to both Questions 3a and 3b. Therefore, it seems that there is coherence between the children's written answers and the drawings they created.

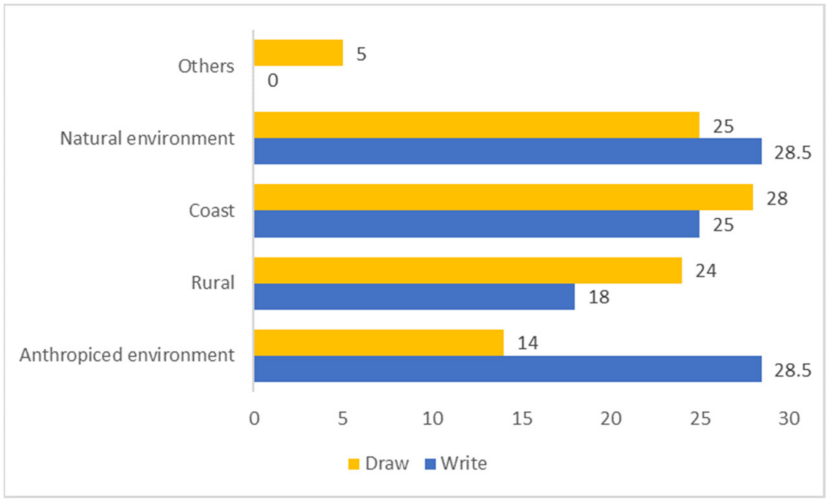


Figure 11. Comparison of Questions 3a and 3b.

Although this study focused on valuing the elements of biodiversity, we were also struck by the fact that approximately 65% of the drawings do not contain the children themselves (or people in general). According to Günindi [65], this happens when children do not feel that they are part of the natural environment.

6. Conclusions and Teaching Implications

Children's preference for anthropized spaces and/or spaces with a medium level of alteration (rural and coastal areas) shows us that, on the one hand, they have a limited perception of the biodiversity of their nearby environment. On the other hand, by assessing their perception of biodiversity, we are able to understand the concept of the environment as a system. Therefore, these results point to three major educational needs that should be covered by science education.

The first is that, in relation to geographical knowledge and the lack of educational experiences in context, there is scarce recognition of the biodiversity of its close surroundings, Andalusia, being a biodiversity hotspot at the European level. Studies such as the one by Llorente-Adán [66] highlight the great ignorance of primary school children about their own environment, as they cannot relate the geographical knowledge studied in the classroom with the area in which they live.

The second is that, in relation to scientific knowledge and misconceptions, there is a conception of the environment that is intuited, such as an accumulation of elements, which may or may not be shown in order or may be shown without clear links being made between them. Although many children acknowledged the different elements of ecosystems, few children depicted interactions between these components [29]. Although this egocentric conception of the environment is typical in primary-age children, according to their maturation stage and level of knowledge [32], in secondary education [35] and even at university levels [3], this conception may continue. Another feature related to this egocentric view includes the use of anthropomorphic language and ideas, which can foster subjectivity and create misconceptions in children, who may not be able to distinguish fact from fiction [42].

The third is the need to improve children's science skills, such as their observations of the environment. The poverty (variety and quantity) of elements that the children represent in their drawings shows their limited capacity to identify the biodiversity of their environment. In general, the experiential place that is represented in the children's drawings is very small [32]. Children represent elements of their mesocosm (the Sun, clouds, trees, and sheets of water) but not of their macrocosm (relationships between elements, natural phenomena, weather changes, etc.) and microcosm (insects, rocks and minerals, herbs, etc.).

To change this, we defend the teaching of biodiversity in context [44,45]. In this sense, outdoor education encourages contextualized learning where children can learn in their nearby environment. In this way, they will be able to gain scientific knowledge and skills, as well as sustainable values and attitudes towards their environmental heritage [3,67].

Finally, all these findings point out the need to improve teacher training in science education. First, as observed in the educational curriculum, the treatment of biodiversity at the national level and in Andalusia is still incomplete and limited. Therefore, it is necessary to improve this treatment of biodiversity within the curriculum so that primary teachers can follow the recommendations. Second, future primary teachers do not usually have outdoor experiences during their initial training in Spain [57]. This is a relevant issue if we, as teacher trainers, want them to be able to design outdoor experiences or fieldtrips in the future with their students. In fact [68], just 31% of student teachers design fieldtrips. In other contexts, in the United Kingdom and USA, the studies of Maynard and Chicken [69] and James and Williams [70] point out that schoolteachers do not usually do fieldtrips as a consequence of the difficulties of managing groups of children outdoors and the possible risks associated with this. However, teacher trainers should promote these kinds of educational experiences among our student teachers. On the one hand, this would

reduce their fear and insecurities regarding outdoor experiences. In this sense, this could be a good option during the *practicum* or practical training in primary schools, where teacher students learn alongside other teachers and children. On the other hand, this could promote contextualized learning through the use of teachers' nearby environments, which offer multiple educational opportunities.

In summary, these findings suggest the need for new methods of teaching and learning biodiversity that more innovative and in line with current research into meaningful and high-quality learning. In both initial and continued training, more experiential teaching and learning situations should be promoted, linked to real and natural contexts and based on addressing problems or challenges regarding the environment. This context should serve to develop an attitude of awareness, participation, and decision making in the face of the great problems that we are facing today [43].

7. Limitations of the Study

The results of this study suggest some research challenges. Although the purpose of this study was not to establish generalizations, this work should be understood as the first approach that analyzes children's perceptions of the biodiversity of their nearby environment. Moreover, it would be interesting to replicate the study by selecting a larger and more representative sample of students based on their socioeconomic level. In this way, rural, urban, and marginal primary schools of a high, medium, and low economic level could all participate. In addition, although we used a combination of different types of data (drawings and student narratives) to discuss the results, the analysis of drawings has its limitations, with the first being children's own ability to represent their thoughts through their drawings and the second our capacity to interpret the most complex drawings or those that were not clear enough [71].

However, drawings are an interesting tool since they offer a wide variety of information to be interpreted, from the colors children use to the methods they employ, the localization and size of objects, and so on, if the methodological strategies used are adequate. The methodological bases for the analysis of children's drawings have not yet been sufficiently developed, since the main challenge is to establish a more standardized approach [72]. For this reason, it would be advisable to use different instruments (interviews, activities, etc.) as well as qualitative and quantitative analysis procedures to gain a richer understanding of children's perceptions.

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