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# An Integrated Model Approach of Education for Sustainable Development: Exploring the Concepts of Water, Energy and Waste in Primary Education

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**Abstract:** Education for Sustainable Development requires improving the knowledge, attitudes and behaviors of students at all levels of education. However, this should start from the earliest stages of education, promoting an effective teaching/learning process of key concepts for sustainable development. Accordingly, the general objective of this research was to analyze the concepts of water, energy and waste in the primary education curriculum (6–12 years) in Spain. A qualitative research approach was followed, with an exploratory and descriptive design. A system of categories was established for each of the concepts under study, with the aim of classifying the references found, analyzing their integration into the different subjects, academic courses, curricular elements and levels of cognitive demand required of the students. The results of the lexicographical analysis of the content reveal that the regulations governing primary education in Spain mainly focus on the concept of energy and, to a lesser extent, on the concepts of water and waste. In addition, cognitive levels of knowledge and comprehension predominate based on the taxonomy used. The results suggest the need to develop initiatives for the educational framework that promote not only learning, but also attitudes and behaviors that contribute to achieving the Sustainable Development Goals (SDGs).

**Keywords:** education for sustainable development; competences for sustainability; primary education; curriculum; waste; water; energy

## 1. Introduction

The economic power that has been anchored in cities and the accompanying technological changes have allowed them to become larger and more extensive. However, the great growth of urbanized areas has brought environmental consequences of global proportions [1]. It is clear that the reality is quite unsustainable for our planet, as more and more energy resources are used, more and more drinking water is used, and more and more waste is generated. If we add to this the fact that the population is growing exponentially, it seems that in a short time energy resources and water will be exhausted and the generation of waste will multiply exponentially. According to some authors [2], this is due to the fact that a growth model based on consumption has been created. However, as some studies [3] indicate, the objectives of companies and institutions are at odds with environmental problems and the apparent consensus with environmental policies is not real due to individual interests and confrontations and competition within the market.

On this basis, any issue related to sustainability is currently of high interest to society [4–6], as citizens are concerned about environmental problems and how they affect the health of our planet. These issues are complex, global and deeply interconnected challenges, requiring collective and

individual action [7,8]. This is why the words sustainable, renewable, efficient or ecological have become buzzwords in recent years, focusing on the search for solutions to problems generated by actions related to, for example, energy use, water use or the generation of waste. Specifically, these three concepts are considered as keys to sustainable development.

Generally speaking, today's society is very sensitive to environmental problems generated by human activities [9], but some research [10] on the environment shows that there is a society that is interested but not concerned. Moreover, according to previous studies [2], the population is not adequately trained in many current issues closely related to sustainable development. Given the current challenges that society faces, the world needs new and more scientifically competent citizens and professionals to address the current environmental threats to sustainability. Some studies suggest that teachers are interested in working on sustainability concerns, aware of the positive impact this has on their own teaching, as well as on strengthening student attitudes [11]. In addition, another previous study [12] analyzed the level of knowledge that future teachers have about waste and concluded that there is a need to promote sustainability education programs to enhance sustainable knowledge and attitudes towards waste management. Other authors examined students' knowledge of waste management and their attitudes towards consumption [12,13]. The results revealed the need to improve both knowledge [12] and attitudes in this field [13]. On the other hand, other authors [14] analyzed the presence of STS aspects (Science, Technology, Society) in the most commonly used secondary education textbooks in the United States. These authors found that, on average, less than 7% of the narrative space was devoted to these aspects. Regarding energy contents, some authors [15] have examined the STS approach in the treatment of nuclear energy in physics and chemistry textbooks of the 3rd year of secondary school of eleven publishers. These authors have highlighted the scarce presence of allusions to the socio-economic and political aspects of nuclear energy, despite the recommendations of the curriculum in favor of the treatment of controversial and current problems. Therefore, they acknowledge that there is a certain resistance to introduce STS-type activities in the texts. Along the same lines are some of the results reached by other researchers [16] who have examined the treatment of electricity in a sample of textbooks of the subject Technology in secondary education. These authors concluded that important aspects such as the environmental impact related to this subject are ignored. On the other hand, other researchers [17] have shown that the attention and space given to non-renewable energies is greater than that given to renewable energies and conclude that the texts emphasize the traditional rather than the future possibilities. Likewise, these authors indicate that the attention paid by the curriculum to the subject of energy does not correspond to that given in the texts analyzed and, therefore, it is necessary to resort to the context of the real problems that humanity currently faces in this regard. At the same time, some studies [18] refer to the environmental problems surrounding water and their repercussions on society and politics and stress the importance of introducing other aspects into educational content; for example, those related to the cost of water and its distribution among consumers and beneficiaries, because this can very effectively explain the consequences of unfortunate management in environmental terms in the country. In this way, it can be taught that new planning and distribution of costs can help to protect and maintain aquatic ecosystems. Along these lines, another study [19] shows that a more rigorous treatment of the concept of water at the first educational levels is necessary in order to understand phenomena such as the permeability of different materials, the penetration of water into the soil or the existence and circulation of water in the subsoil.

Taking into account these conceptual shortcomings in the educational framework, the degree of teacher involvement, as well as the approach to these problems in the classroom through close, everyday actions, are essential elements for motivating and awakening student interest [20]. Some authors [21] recommend working on this type of problem in the classroom, to promote critical thinking, democratic values and the active search for solutions, aspects that imply the domain of necessary scientific knowledge [22]. Consequently, science education needs to change the perception and understanding of these problems by incorporating a STSE (Science–Technology–Society–Environment)

perspective [23]. There is a need for education that helps individuals to interpret, understand and know the complexity and globality of the problems that occur in the world and teach attitudes, knowledge, values or behaviors that promote a sustainable way of life. Thus, it is necessary to influence economic, social, political and cultural changes in order to achieve a development model that involves not only environmental improvement, but also social, economic and political improvement at a global level [24]. In this sense, among the basic training to students from the STSE point of view, only a purely environmental education has been set up, which is mainly in the areas of natural and social sciences. For example, the contribution of physics is essentially relevant through the subject of energy, while chemistry deals with aspects such as the treatment of polluted water or air pollution by exhaust gases, and geography through topics related to environmental problems in other countries [25]. This conception suggests that biology, geography or social studies are the core subjects of environmentally oriented subjects in schools. With physics and chemistry as complements, however, sustainability issues encompass many other topics (economic, social or cultural) that can be considered in many other academic disciplines, making interdisciplinarity a central idea in sustainability science [26,27]. As a result, sustainability issues have begun to be included in other subjects, such as ethics and the environment, in the teaching of religion or the environmental impact of poverty in the subject of history [25].

In addition, the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, has made a significant contribution to promoting the widespread use of the term sustainable development, reaffirming its conceptual interest and need as a strategic planning tool for the solution of current environmental problems [28]. As a result, over the past few years, training and education activities on environmental issues have been integrated into a wide range of fields; for example, at the institutional, business and mass-media levels, and of course in the educational system. The latter is of particular interest because it is a channel to which the entire population has access and, moreover, is in its early stages of socialization, and it can therefore have a greater influence on the widespread achievement of new habits and behaviors whose impact on the environment is not as harmful as it is today [29]. The role that education must play in this process of change is also clearly reflected in the United Nations Educational, Scientific and Cultural Organization's (UNESCO) approach to the Decade of Education for Sustainable Development (2005–2014) [30]. Thus, it is recognized that both scientific and technological knowledge must form part of citizenship anywhere on the planet, thereby enabling citizens to develop sustainable attitudes so that they can take a critical view of the environment and all related problems [2]. On the other hand, the United Nations Assembly, in September 2015, also adopted the Sustainable Development Goals (SDGs) as an international agenda with the purpose of guiding development policies within the next 15 years, so that the countries of the world continue their efforts to address poverty, inequality and climate change [5,31]. In this line, recent research [32] has focused on analyzing the vertical integration of SDGs in higher education. Specifically, the authors analyze whether at least one SDG is promoted in Portuguese public higher education institutions.

Given the previous background, it is assumed that the concept of sustainable development has been integrated into the educational curriculum of different countries as compulsory learning content following the insistence of various institutions [33–36]. It is not difficult to identify, in our curriculum, where we are and where we are not integrating the concept of sustainability into our educational practices [37,38]. In addition, the role of textbooks in interpreting the curriculum's provisions becomes important because of their predominance as vehicles for carrying school knowledge [16,33,39]. However, the reality is that school-based approaches should also incorporate a community sustainability education program that improves citizens' knowledge, attitudes and behavior in relation to sustainability [40]. In this regard, it is appropriate to highlight some of the UN's proposed Sustainable Development Goals [5,41] as they are closely linked to the theme of this study. SDG 6, "Clean Water and Sanitation", aims to make people aware that the scarcity of water resources, together with the poor quality of water and inadequate sanitation, have an impact on food security and livelihoods, among other aspects. Mention should also be made of SDG 7, "Affordable and Clean Energy", which aims to support

economic and employment initiatives that ensure universal access to modern energy services, improve energy efficiency and increase the use of renewable sources to create more sustainable and inclusive communities, as well as for resilience to environmental challenges such as climate change. Finally, SDG 12, “Responsible Consumption and Production”, aims to raise consumer awareness through education on sustainable lifestyles, providing them with appropriate information through labelling and usage standards, among others.

Taking into account the abovementioned antecedents, this paper is based on previous studies in which references to the concept of waste [36], energy [35] and water [42] are analyzed across the curriculum that unifies compulsory secondary education (CSE) and baccalaureate education in Spain. In the present investigation and taking into account the need to begin to forge pro-environmental knowledge and attitudes from early ages [43], the basic curriculum of primary education in Spain, regulated by Royal Decree 126/2014, is analyzed. Specifically, the treatment of the concepts of water, energy and waste in the regulations is emphasized.

## 2. Methodology

The methodology of the research carried out was exploratory, descriptive and mixed, using a research design similar to that used in other investigations [33–36]. Specifically, a lexicographical analysis of the content of the primary education curriculum on the concepts of water, energy and waste from a sustainable perspective was carried out. The words water, energy and waste and all the statements related to them in the Royal Decree 126/2014 were qualitatively analyzed. The subjects, courses and curricular element of the different references found were taken into account. Based on these references, a system of categories was established, which is detailed in the following section.

### 2.1. Objectives

The main objective of the research was to analyze the treatment of the concepts of water, energy and waste from a sustainable perspective in the regulations governing primary education in Spain (6–12 years). This general objective has been broken down into the following specific objectives:

- Specific Objective 1 (SO1): To create a system of categories based on the perspective of sustainability and responsibility for each of the chosen concepts (water, energy and waste).
- Specific Objective 2 (SO2): To analyze the references to the concepts under study in the Royal Decree 126/2014 that regulates the primary education curriculum in Spain.
- Specific Objective 3 (SO3): To analyze the subjects in which the concepts of water, energy and waste are taught.
- Specific Objective 4 (SO4): To analyze in which curricular elements are included the references found to the concept of water, energy and waste.
- Specific Objective 5 (SO5): To compare the presence of the concepts under study in the educational regulations of primary education with those of secondary and baccalaureate education, analyzed in previous studies [35,36,42].
- Specific Objective 6 (SO6): To analyze the cognitive demand that is required from the primary education student on the concepts of waste, energy and water, taking as a reference the categories established for each of them.

### 2.2. Sample and Procedures

In order to explain the responsible and sustainable approach to waste, water and energy implicit in the regulations governing primary education in Spain, all references to the concept of waste, water and energy were analyzed. Of all of these, those related to the development of efficiency, sustainability and related elements were taken into account, but in some cases, those references of a more theoretical nature were also included.

Based on the analysis of all the statements, several categories were established that allow the classification of references to the fields of energy, water and waste included in the regulations analyzed. Therefore, based on the Specific Objective 1 proposed in the research (SO1), the following categories were established for each of the study concepts.

The references found on the concept of waste were included in the following categories:

- Category I—Awareness (Aw): Groups together references related to the social and environmental impact of correct waste disposal.

With regard to the concept of energy, the statements found were divided into the following categories:

- Category I—Energy Sources (ES): It includes those references to the different sources of energies existing on our planet.
- Category II—Consumption/Use (CU): It includes references to the importance of the use of energy from its generation, transport and distribution, as well as the consumption that is made both at industrial and personal level.
- Category III—Awareness and Ethics (AE): Groups together references related to the social and environmental impact of the correct use of energy.
- Category IV—Energy Efficiency (EE): Includes references related to all elements related to sustainability and energy efficiency in the field of energy.

With regard to the concept of water, the categories established in the study were the following:

- Category I—Technology (Te): References that contribute to the technological development to achieve the correct solutions to water related problems.
- Category II—Sustainability and Responsibility (SR): References related to sustainability in terms of consumption and rational use of the limited and scarce goods of our planet.
- Category III—The Water (Wa): It includes those references to theoretical aspects related to water.

In creating the categories, the educational perspective was linked to responsible, efficient and sustainable attitudes in all cases. In this way, the concept of waste was analyzed taking into account the factors from an ethical and awareness point of view and the Category I—Awareness was generated. In the case of the concept of energy, aspects related to the cognitive domain of the subject (Category I—Energy Sources), aspects linked to the expense produced (Category II—Consumption/use), consciousness (Category III—Awareness and Ethics) and those related to technological development issues (Category IV—Energy Efficiency) were considered. Finally, to classify the references to the concept of water, three categories were generated: Category I—Technology, which includes references related to technological development; Category II—Sustainability and Responsibility, based on considering the statements linked to sustainable attitudes; and Category III—Water, which includes references that allude to the terms and theoretical issues related to water that primary school students must know.

### 3. Results

The results obtained after the lexicographical analysis of Royal Decree 126/2014 [44] in relation to the concepts under study are shown first. The subjects linked to them are shown, as well as the educational level or levels at which they are incorporated and the curricular elements to which each concept refers. Subsequently, a comparison is made between Royal Decree 1105/2014 [45], which regulates secondary education and baccalaureate education, and the legislation on primary education, Royal Decree 126/2014 [44], in relation to the concepts of water, waste and energy in these educational regulations. Finally, a detailed analysis of the references found in each concept is shown to verify the cognitive demand required of primary school students on the main concepts of the study.

### 3.1. Results of the Lexicographical Analysis of the Concept of Waste, Energy and Water in the Regulations Analyzed (SO1 and SO2)

This section shows the results obtained regarding the Specific Objectives 1 (SO1) and 2 (SO2) proposed in this research. Table 1 shows the frequency (n) and percentage (%) of references to water, energy and waste, from a sustainable perspective, found in the primary education curriculum.

**Table 1.** Frequency (n) and percentage (%) of references to water, energy and waste, from the point of view of responsibility and development in the Royal Decree regulating primary education in Spain.

Regulation	Values	Water	Energy	Waste	Total
Royal Decree 126/2014	Frequency (n)	24	74	6	104
	Percentage (%)	23.07%	71.15%	5.70%	100%

As can be seen in Table 1, references to the concepts of waste, energy and water appear 104 times in Royal Decree 126/2014. The concept with the greatest number of references is energy, which presents 74 references (71.15% of the total references found) in the primary education curriculum. The concepts of water and waste appeared 23.07% and 5.7%, respectively. These results indicate that there is great social awareness of the issue of water, but, above all, of the issue of energy, perhaps because of its direct impact on people's daily lives. On the contrary, it could be assumed that the issue of waste is not considered so fundamental by educational institutions since its inclusion in the curriculum is scarce.

Table 2 shows the frequency (n) and percentage (%) of references found in each concept, distinguishing by category.

**Table 2.** Frequency (n) and percentage (%) of references in relation to the total of each concept by category.

Concepts	Categories	Royal Decree 126/2014	
		n	%
Waste	I—Awareness	6	100
	I—Energy Sources	56	75.67
Energy	II—Consumption/use	8	10.81
	III—Awareness and Ethics	6	8.10
	IV—Energy Efficiency	4	5.40
	I—Technology	2	8.33
Water	II—Sustainability and Responsibility	1	4.16
	III—The Water	21	87.50

With respect to the data shown in Table 2, it is observed that, within the concept of energy, Category I—Energy Sources includes the majority (75.67%) of the references found in this concept. Likewise, Category IV of this concept (Energy Efficiency) is the one with the lowest number of references (5.40% of the total of the energy concept). The categories of Consumption/Use (Category II) and Awareness and Ethics (Category III) show similar percentages, 10.81% and 8.10%, respectively. In addition, with respect to the concept of water, it should be noted that it is Category III (Water) that includes the greatest number of references (87.50% of the total of this concept). On the contrary, the references related to Category II (Sustainability and Responsibility) appear in 4.16% of the total for the concept of water. Similarly, Category I—Technology, appears with 8.33% of the total number of references to this concept.

### 3.2. Results of the Analysis of the Subjects and Curricular Elements Referred to the Concepts of Waste, Energy and Water in the Regulations Analyzed (SO3 and SO4)

Based on the Specific Objectives 3 and 4 of the research (SO3 and SO4), all the references recorded in Royal Decree 126/2014 on the concept of energy, water and waste are presented in Tables 3–10, classified by categories, subjects, academic year and the curricular elements in which they appear.

It is specified whether the statement analyzed is found in the Content (Co) of the curriculum, in an Evaluation Criterion (EC), in a Learning Standard (LS) or in the Introduction to the Subject (In). Specifically, the analysis of the curriculum reveals that the concepts under study are taught in a total of four subjects during the primary education stage. As can be seen in Table 3, during the six years of primary education, pupils study the concept of waste specifically in the subject of physical education, where it is stated that the student should be responsible for the disposal of waste generated by the activities carried out. Meanwhile, the concept of energy (Tables 4–7) is referred to during all educational levels and specifically worked on in the subjects of Natural Sciences, Social Sciences and Social and Civic Values. The concept of water (Tables 8–10) is studied in the subjects of Social Sciences and Natural Sciences and, although it appears included as an introductory concept of the subject Social Sciences, this concept is worked on from the 2<sup>nd</sup> grade of primary education in a specific way.

**Table 3.** Statements linked to waste that appear in Royal Decree 126/2014 in primary education (Category I: Awareness). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Waste. Category I: Awareness (Aw)							
Reference	Subject	Year	Co	EC	LS	In	Total
Is responsible for the disposal of the waste generated by the activities in the natural environment.	Physical Education	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>				6	6

**Table 4.** Statements linked to energy that appear in Royal Decree 126/2014 in primary education (Category I: Energy Sources). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Energy. Category I: Energy Sources (ES)							
Reference	Subject	Year	Co	EC	LS	In	Total
Concept of energy.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>	2				2
Different forms of energy.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>	2				2
Identifies and explains the main characteristics of energy forms.	Natural Sciences	4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>				3	3
Energy sources.	Natural Sciences	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	8				8
Identifies the different sources of energy and raw materials and their origin.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>				2	2
Responsible use of energy sources.	Social and Civic Values	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	6				6
To value the responsible use of energy sources on the planet by being aware of the respect for the environment.	Social and Civic Values	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>		6			6
Acknowledges the limitation of energy resources and explains the consequences of the depletion of energy sources.	Social and Civic Values	4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>				5	5
Renewable and non-renewable energies.	Natural Sciences	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	8				8
Identifies and explains some of the main characteristics of renewable and non-renewable energy.	Natural Sciences	3 <sup>rd</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>				3	3
Light as an energy source.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>	2				2
Energy sources and raw materials.	Natural Sciences	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	4				4
Identifies and explains the main characteristics of renewable and non-renewable energies, identifying the different sources of energy and raw materials and the origin from which they come.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>				2	2
Identifies and explains some of the main characteristics of renewable and non-renewable energy.	Natural Sciences	3 <sup>rd</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>				3	3

**Table 5.** Statements linked to energy that appear in Royal Decree 126/2014 in primary education (Category II: Consumption/Use). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Energy. Category II: Consumption/use (CU)							
Reference	Subject	Year	Co	EC	LS	In	Total
Identifies and explains the benefits and risks related to the use of energy: depletion, acid rain, radioactivity, exposing possible actions for a sustainable development.	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>			2		2
To value the responsible use of energy sources on the planet, being aware of the respect for the environment and developing the critical capacity towards the events that modify it.	Social and Civic Values	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>		4			4
Investigates the effects of abuse of certain energy sources.	Social and Civic Values	5 <sup>th</sup> and 6 <sup>th</sup>			2		2

**Table 6.** Statements linked to energy that appear in Royal Decree 126/2014 in primary education (Category II: Awareness and Ethics). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Energy. Category III: Awareness and Ethics (AE)							
Reference	Subject	Year	Co	EC	LS	In	Total
Acknowledges the limitation of energy resources and explains the consequences of the depletion of energy sources.	Social and Civic Values	1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>			6		6

**Table 7.** Statements linked to energy that appear in Royal Decree 126/2014 in primary education (Category IV: Energy Efficiency). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Energy. Category IV: Energy Efficiency (EE)							
Reference	Subject	Year	Co	EC	LS	In	Total
Sustainable and equitable energy development.	Natural Sciences	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	4				4

**Table 8.** Statements linked to water that appear in Royal Decree 126/2014 in primary education (Category I: Technology). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Water. Category I: Technology (Te)							
Reference	Subject	Year	Co	EC	LS	In	Total
Observes, identifies and describes some advances in science that improve health (medicine, food production and conservation, water purification, etc.)	Natural Sciences	5 <sup>th</sup> and 6 <sup>th</sup>			2		2

**Table 9.** Statements linked to water that appear in Royal Decree 126/2014 in primary education (Category II: Sustainability and Responsibility). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Water. Category II: Sustainability and Responsibility (SR)							
Reference	Subject	Year	Co	EC	LS	In	Total
Water and responsible consumption.	Social Sciences	-				1	1



**Table 10.** Statements linked to water that appear in Royal Decree 126/2014 in primary education (Category III: The Water). Abbreviations: Contents (Co), Evaluation Criteria (EC), Learning Standards (LS) and Introduction (In).

Water. Category III: The Water (WA)							
Reference	Subject	Year	Co	EC	LS	In	Total
The water. Solid, liquid and gaseous states.	Natural Sciences	2 <sup>nd</sup>	1				1
Observes and describes, through experimentation, some characteristics of water.	Natural Sciences	2 <sup>nd</sup>			1		1
Identifies and compares the solid, liquid and gaseous states of water.	Natural Sciences	2 <sup>nd</sup>			2		2
Plans and carries out simple experiments and describes the changes that occur in materials when force, light, heat and water are applied.	Natural Sciences	2 <sup>nd</sup>			1		1
Distribution of water on the planet.	Social Sciences	2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>	5				5
To explain the hydrosphere, identify and name water bodies and courses, differentiating surface water and groundwater, basins and watersheds, describing the water cycle.	Social Sciences	3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>		4			4
Defines the hydrosphere, and identifies and names water bodies and courses, explaining how groundwater is formed, how it emerges and how it is accessed.	Social Sciences	2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> and 6 <sup>th</sup>			5		5
Describes in order the phases in which the water cycle takes place.	Social Sciences	5 <sup>th</sup> and 6 <sup>th</sup>			2		2

Firstly, the analysis of the concept of waste is shown. As previously mentioned, waste is worked on very little during the primary stage, although it should be noted that the mention of waste in the curriculum is related to sustainable attitudes. Table 3 shows the statements linked to Category I—Awareness of the concept of waste.

As shown in Table 3, there is a total of six learning references on the concept of waste in the primary education curriculum. Specifically, the topic of waste appears as a learning standard at all educational levels and is specifically worked on in the area of Physical Education. Taking into account the impact of waste on the environment [46] and the current attitude of uncontrolled over-consumption [47], it would be advisable to deal with this concept in greater depth from the earliest school ages.

The analysis of the concept of energy in the primary school curriculum is shown below. It is a term that is studied in great depth during the primary stage, both at the theoretical level and at the level of sustainability. Table 4 shows the statements linked to Category I—Energy Sources of the energy concept. It can be seen that the study of energy sources has great relevance in the primary stage since a total of 56 references to them were found in the primary school curriculum. Likewise, it is verified that it is a content included in the subjects Nature Sciences and Social and Civic Values and it has a place in all the levels of the primary stage. Specifically, the first two years of the stage, the 1<sup>st</sup> and 2<sup>nd</sup> year of primary education, contemplate energy sources as content of the subject Social and Civic Values. In the last levels of the stage, energy sources are also included in the subject area of Natural Sciences in the form of a learning standard or evaluation criterion depending on the complexity associated with the educational level.

Table 5 shows the references to the concept of energy related to Category II—Consumption/Use.

Table 5 indicates that the primary school curriculum includes aspects of energy consumption and use in the subject of Natural Sciences as a learning standard for the 5<sup>th</sup> and 6<sup>th</sup> grades. Likewise, it appears in the subject of Social and Civic Values from the 3<sup>rd</sup> year as an evaluation criterion and as a learning standard, with a total of eight references in the curriculum to this category.

Table 6 presents the statements linked to Category III—Awareness and Ethics derived from the concept of energy.

As can be seen in Table 6, the concept of energy linked to issues of sustainable attitudes only appears once at each primary level, as a learning standard and in the subject of Social and Civic Values. This reference focuses on checking that the students assume that energy sources are limited and therefore it is necessary to be respectful with their use. However, taking into account the need to inculcate sustainable attitudes in students, we consider that it would be appropriate to expand the primary school curriculum in this sense.

Table 7 shows the results obtained after analyzing the references obtained in Category IV of the energy concept.

As can be seen in Table 7, aspects related to energy efficiency are considered in the subject of Natural Sciences on four occasions, specifically from the 3<sup>rd</sup> year of primary school up to the last level of the stage. The primary school curriculum includes content from the 3<sup>rd</sup> grade onwards that refers to sustainable and equitable energy development.

With respect to the concept of water, it should be noted that it is a concept that is worked on extensively at a theoretical level, but few references to the concept were found in relation to sustainable development, as shown below. Table 8 shows the statements found in Royal Decree 126/2014 that could be included in its first category, Technology.

Table 8 shows the two occasions in which technological aspects related to water could be worked on in primary schools. Specifically, this category would be included as a learning standard in the subject of Natural Sciences and would be worked on by 5<sup>th</sup> and 6<sup>th</sup> grade primary students. Likewise, we could accept that these two mentions have some relation with teaching in sustainability.

Table 9 shows the references related to Category II—Sustainability and Responsibility of the concept of water.

Table 9 shows that the only time that water is directly related to sustainable aspects in the primary school curriculum is in the introductory paragraph of the Social Sciences subject. However, no references on sustainability and responsibility with water were found after the introduction of the Social Sciences subject.

Table 10 shows the 21 references related to the concept of water at a theoretical level (Category III—The Water).

Table 10 reveals that primary school students must acquire basic and specific notions related to water, but in no case are these notions directly linked to sustainability. Water, as a theoretical concept, is specified in the subject of Natural Sciences as a content and learning standard in the second year of primary school. Likewise, from the 2<sup>nd</sup> to the 6<sup>th</sup> year of primary school, this concept is also emphasized in the area of Social Sciences, as it is included in the curriculum as curricular content, evaluation criteria or learning standards according to the educational level.

After analyzing the primary curriculum, it is noted that most of the courses addressing aspects of sustainable development come from the fields of social sciences and humanities and natural sciences. In addition, it is assumed that incentives for an integrated sustainability curriculum face several obstacles, such as the amount and importance of learning purely theoretical knowledge, the need to work on all of them, and the lack of knowledge on the part of teachers to link this theoretical content to a sustainability perspective [12]. We agree with [48] that education for sustainability is a limited discipline because little attention is paid to more advanced concepts (as the necessary interdisciplinary approaches and their institutionalization or transdisciplinarity; that is, active collaboration with various stakeholders throughout society), their application and the generation of new knowledge that links theory with sustainability attitudes.

### 3.3. Results of the Comparison of the Primary Education Curriculum with the Secondary Education and Baccalaureate Curriculum (SO5)

This section shows the results related to Specific Objective 5 of the research (SO5). After analyzing the primary school curriculum [44] for the selected concepts, a comparison was made with the secondary school and baccalaureate curricula [45], since the concepts of water, waste and energy were also analyzed in previous studies [35,36,42].

Table 11 shows data on the frequency with which the concepts of water, waste and energy appear in the primary education curriculum [44] compared to the secondary education curriculum [45].

**Table 11.** Number of times (n) that primary, secondary and baccalaureate educational regulation mention energy, waste and water.

Regulation		WASTE	ENERGY	WATER	TOTAL
Royal Decree	n	18	64	31	113
1105/2014	%	15.92	56.63	27.43	100
Royal Decree	n	6	74	24	104
126/2014	%	5.76	71.15	23.07	100

As can be seen in Table 11, the concept of energy is the one that is most deeply studied during school training, both in primary and in secondary and baccalaureate education (although it is true that this concept is studied in more depth) during the primary stage than in secondary and baccalaureate education, as it is reflected a total of 74 times in Royal Decree 126/2014 as opposed to 64 times in Royal Decree 1105/2014. These data are relevant since the concept of energy is included in six secondary education subjects according to Royal Decree 1105/2014 [35] compared to the two subjects that work on it in primary education.

With respect to the concept of waste, regardless of the school stage, it is important to highlight the scarce inclusion of this concept in Spanish legislation and, therefore, its scarce treatment in terms of sustainability, even taking into account the current need to promote sustainable attitudes with respect to consumption and generation of waste [12,49]. The concept of waste is reflected 18 times in the secondary and baccalaureate curricula and is worked on in both secondary and baccalaureate education in different subjects related to science and technology and, conversely, this content appears only six times in the primary curriculum and is included in the subject of Physical Education.

Finally, the concept of water is contained 31 times in the secondary and baccalaureate curricula and 24 times in the primary curriculum. It should be noted that in the case of primary school, this content is treated in the classroom in a more theoretical way than in relation to sustainable attitudes, and it is not until the secondary and baccalaureate stages that this concept is related to aspects linked to sustainability; for example, through the study of the contamination of fresh and saltwater, the rational use and sustainable management of water or knowing how to describe the properties of water and its importance for the existence of life [42,45].

### 3.4. Results of the Qualitative Analysis of the Cognitive Demand of the Concepts Selected in Educational Legislation (SO6)

In order to achieve Specific Objective 6 of the research (SO6), this section presents the analysis of the cognitive demand linked to each reference found in the curriculum on the different concepts studied, namely waste, energy and water [50]. Specifically, the different references found in the curriculum were classified according to the educational objectives pursued with them, based on Bloom's taxonomy, a classification that groups the intellectual performance that students must achieve during their schooling [35,51,52]. This classification covers several areas, taking into account the level of difficulty required of students, including knowledge, comprehension, application, analysis, synthesis and evaluation [51].

Table 12 below shows the percentage and frequency of references on waste linked to the different levels of cognitive demand required of primary school pupils.

**Table 12.** Frequency (n) and percentage (%) of cognitive demand levels according to Bloom's taxonomy for the concept of waste.

Waste	Frequency	Percentage
Knowledge	-	
Comprehension	-	
Application	6	100%
Analysis	-	
Synthesis	-	
Evaluation	-	
Total	6	100%

As can be seen in Table 12, the only level expected to be developed in primary school pupils in relation to waste is that of application, with a total of six references included in this area. Considering the concept of waste, the rest of the levels included in Bloom's taxonomy have no place during primary education.

Table 13 shows the references to the concept of energy classified according to Bloom's taxonomy [51] to check what cognitive demand is required of primary school pupils in relation to this concept.

**Table 13.** Frequency (n) and percentage (%) of cognitive demand levels according to Bloom's taxonomy for the concept of energy.

Energy	Frequency	Percentage
Knowledge	36	42.3%
Comprehension	26	30.5%
Application	-	-
Analysis	2	2.3%
Synthesis	-	-
Evaluation	21	24.7%
Total	85	100%

Table 13 shows that cognitive demand is focused on knowledge, since 42.3% of the references classified are included in this level, followed by 30.5% of references included in the level of comprehension. This suggests that the cognitive demand required of students during their primary education in relation to energy is mainly conceptual. However, 24.7% of the references are included in the last level of Bloom's classification, the evaluation, the level with the highest cognitive demand. The statements with the lowest percentages are those in which the student is required to analyze, which is less than 3% of the total of the statements analyzed.

Table 14 shows the references to water and its classification by level of cognitive demand.

**Table 14.** Frequency (n) and percentage (%) of cognitive demand levels according to Bloom's taxonomy for the concept of water.

Water	Frequency	Percentage
Knowledge	12	38.7%
Comprehension	17	54.8%
Application	1	3.2%
Analysis	-	-
Synthesis	1	3.2%
Evaluation	-	-
Total	31	100%

As can be seen in Table 14, during the first stage it is expected that the students acquire a fundamentally conceptual learning of the contents related to water since the analysis of the cognitive demand of the concept reveals that 38.7% of the references found are included within the knowledge area and 54.8% of the sentences fit within the level of comprehension. The demand for application and synthesis is reported in equal percentages, 3.2% in both cases.

#### 4. Discussion and Conclusions

Firstly, it should be stressed that Spanish legislation gives high importance to the concept of energy and not so much to that of water and waste. We agree, at the same time, with other authors [33] that the primary education curriculum does not often incorporate the term sustainability in relation to the concepts under study.

Specifically, the concept of energy is incorporated into the curricula of the subjects Nature Sciences and Social and Civic Values, the concept of water is included in the subjects Social Sciences and Nature Sciences and the concept of waste is only reflected in the subject of Physical Education. Consequently, these results reveal that great importance is placed on the study of energy during the primary education stage, thus coinciding with previous studies [35], which conclude that the concept of energy from the point of view of sustainable development has a clear impact on educational legislation in Spain, although it is true that the data confirm that this concept is studied with greater incidence at the primary stage than at the secondary stage. Furthermore, these data are also consistent with those of other research studies [36], which indicate that the concept of waste is barely mentioned in current Spanish curricula. Likewise, it is concluded that, although the concept of water appears to be reflected in the primary curriculum, its treatment in the classroom seems to acquire a more conceptual character and those sustainable nuances that can be associated with this concept are left aside. These results allow us to conclude that it is necessary to have a greater impact on content focused on education for sustainability from an early age, mainly to instill in students those measures that address the current global emergency situation and achieve sustainable development [53]. It is essential to train citizens to become scientifically literate in all areas in accordance with current needs [54], since it is recognized that this scientific and technological development is only reflected in issues related to the field of energy. It should also be borne in mind that the United Nations has placed special emphasis on promoting sustainable attitudes and knowledge from within the educational sphere [55] and has decreed the 17 Sustainable Development Goals [5,31] closely related to the education sector. It would certainly be interesting to consider these contributions in curricula and educational institutions from the earliest school age.

With regard to cognitive demand, it can be stated that most of the existing references in the primary school curriculum on waste, water and energy are linked to the development of knowledge and comprehension skills; that is, primary school students are expected to acquire a certain level of knowledge with regard to these subjects rather than to understand the impact of these concepts on the environment, the economy, culture and society. Consequently, there is a low cognitive demand in those areas of greatest demand that require application of conceptual knowledge, capacity for analysis and synthesis, making connections, making decisions or evaluating reasoning. Education should deploy educational practices to develop basic skills, such as acquiring high levels of reading comprehension and control of one's own understanding, but also of scientific reasoning, such as explaining, interpreting, critically reasoning or making decisions [56]. However, we agree with other studies [57] that it is essential to achieve a conceptual understanding of the subject we are dealing with before tackling its resolution, although it is true that adequate didactics must integrate the processes of assimilation and application of conceptual knowledge [58]. In this sense, we also agree with other research [57] on the importance of providing students with guidelines and criteria to be able to judge their processes and products during problem solving with immediate feedback, as they are fundamental requirements to acquire adequate skills.

Finally, it is concluded that, since sustainable development has been recognized as a concept that could preserve the vitality and variety of our planet and simultaneously allow the improvement of the quality of life, it is essential to adhere to the pedagogical fields of scientific approach and to integrate this concept in all aspects and levels of the educational systems of all countries in the world [59]. In this sense, educating our students in environmental awareness can be a great help for them to appreciate information on how to practice sustainability and environmental conservation [60]. Integrating education for sustainability into the curriculum at all levels of schooling promotes a strong influence on students' knowledge, skills and attitude toward environmental protection [61]. In this regard, the training of future teachers is particularly important because they are the central factor in the successful implementation of education for sustainability. However, for many teachers, especially primary school teachers with limited knowledge of science, current education reform requires more than a change in classroom practice [62]. There is a high percentage of teachers who are not proactive in solving local, national and global environmental problems and show limited knowledge and use of strategies to achieve sustainability goals [63]. In this sense, it is necessary to promote and propose teacher training programs that allow educators in all educational centers to be updated and thus able to assume actions that facilitate and promote student knowledge and awareness of global issues, critical thinking and analytical skills, as well as to assume action to promote positive social and political change and student participation in the defense and conservation of environmental resources.

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