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CreActiva Science Project. How to Raise the Awareness of Non-University Teachers and Students Regarding the Circular Economy?

Ciencia CreActiva. ¿Cómo sensibilizar a docentes y estudiantes de ámbitos educativos no universitarios en la economía circular?

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Abstract

This article is part of a research project funded by the FECYT (Spain) that seeks to improve education in the field of sustainability and technology related to the circular economy among pre-university students in the Castilla-La Mancha community in Spain. Education is the most appropriate entry point for citizen awareness of the circular economy, and actions by teachers subsequently permeate their students. Therefore, this article measures the degree of awareness of non-university education teachers regarding the circular economy, determining the type of didactic action that may be effective, and presents a comprehensive educational intervention carried out with them through a blended learning course. The main teaching resource used was video, with interviews with women scientists and educational experts in the areas of sustainability and the circular economy. The methodology used was quantitative for the analysis of teacher awareness, with a questionnaire being used as an instrument, and qualitative for the analysis of the type of educational action, for which a focus group of experts was used. The results obtained regarding the level of teacher awareness show that the interest of teachers in the circular economy is medium-low and that among the stakeholders the degree of commitment and concern is between high and very high (83%). The dimensions analyzed in the focus group included curricular adaptation, educational measures, methodologies, and resources and materials. At the end of the intervention described, the expectation was to obtain a repository of videos created by the students themselves that could be integrated into new educational proposals, thus promoting greater commitment among the educational community to this problem.

Keywords: awareness, circular economy, didactic video, non-university education, questionnaire, teacher training.

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Resumen

Este artículo forma parte de un proyecto de investigación financiado por la FECYT (Spain) que busca una mejora educativa en el ámbito de la sostenibilidad y la tecnología relacionada con la economía circular entre el alumnado preuniversitario de la Comunidad de Castilla-La Mancha (España). La educación es la más adecuada vía de entrada de la conciencia ciudadana respecto de la economía circular, y las acciones en los docentes permean después a su alumnado. Por ello, en este artículo se midió el grado de sensibilización de los docentes de educación no universitaria en relación con la economía circular, se determinó el tipo de acción didáctica que podía ser efectiva y se presenta una intervención educativa integral llevada a cabo con ellos a través de un curso de formación semipresencial. El principal recurso didáctico utilizado fue el video, con entrevistas a mujeres científicas y a expertos educativos en ámbitos de sostenibilidad y economía circular. La metodología empleada fue cuantitativa en el análisis de la sensibilización del profesorado (para lo que se ha empleado como instrumento un cuestionario), y cualitativa para el análisis del tipo de acción didáctica (grupo focal de expertos). Los resultados acerca del nivel de sensibilización del profesorado obtenidos arrojan que el interés de los docentes por la economía circular es medio-bajo, y que entre los interesados el grado de compromiso y preocupación se sitúa entre alto y muy alto (83%). Las dimensiones analizadas en el grupo focal apuntan a la adecuación curricular, las medidas educativas, las metodologías y los recursos y materiales. Al término de la intervención presentada se espera obtener un repositorio de videos creados por los propios estudiantes que puedan ser integrados en nuevas propuestas educativas, favoreciendo, con ello, un mayor compromiso entre la comunidad educativa ante esta problemática.

Palabras clave: cuestionario, economía circular, educación no universitaria, sensibilización, formación del profesorado, video didáctico.

Introduction

When we talk about municipal solid waste (MSW), or domestic waste (Law 22/2011 of July 28 on Waste and Contaminated Soils), we refer to all waste that is generated due to domestic and commercial activity in towns and cities. This type of waste causes multiple effects, such as atmospheric, edaphic (soil), and groundwater pollution, among others.

In 2007, the total amount of waste generated worldwide was 3.2 gigatons (Gt), of which 1 Gt was recycled or reused, 0.7 Gt was incinerated, converted into gas, fertilizer or aggregates, and 1.5 Gt was dumped in landfills (Tisserant et al., 2017). This flow of materials contains enormous amounts of potentially usable resources and represents a great opportunity to promote the development of the circular economy (hereinafter CE), where states have an important and decisive role, since they are the ones who have to implement the necessary measures and fan the flames of change (Inocêncio da Silva & Ferreira Maia, 2017). However, the reality is that the proportion of MSW that is recycled or reused is still very low. In Spain, for example, that percentage is only 43.3% (Seguí, Medina, & Guerrero, 2018), which is far below the level agreed in the European Circular Economy Action Plan in 2015: to increase recycling of MSW to 65% and reduce the proportion of MSW that goes to landfills to 10% by 2030. In order to meet this target, it would be necessary to increase recycling in the European Union nations from 97 Megatons (Mt).

The climate problem has become a global threat that jeopardizes the sustainability of the current production model, which could lead to a future where essential resources such as fresh water become a source of conflict due to their scarcity. Indeed, it is estimated that the extraction of resources from the Earth is 1.7 times greater than the sustainable capacity (Soto, 2018). Moreover, extractivism is a local problem that facilitates a global solution, constituting the first link in international marketing and production chains (Gudynas, 2015; 2018).

Meanwhile, poor recycling of certain products that contain non-biodegradable materials leads not only to an environmental cost, but also an economic one, since it is estimated that the plastic that ends up in the seas and oceans negatively affects sectors such as tourism or fishing, causing losses of up to 13 trillion dollars (Kaplan, 2015).

That said, in order to achieve these commitments we must act on the basis of citizen education, that is, to educate the youngest members of society and their teachers in knowledge and recognition by appropriating the concept. This makes it essential to have effective environmental education strategies to develop a sense of care and respect for the environment, among both present and future generations (European Commission, 2014; European Commission, 2017). As Molano (2012) argues, highlighting and assessment of this problem is essential, because combating cultural conformism is the first step towards achieving a paradigmatic change.

From this perspective, an ideal environmental education is that in which the individual subjects that make up a society manage to acquire a collective conscience by which they appreciate the conservation of the ecosystem, in such a way that they move towards propitious and effective use of raw materials, meaning their benefits will thus last longer (Macedo & Salgado, 2007). The objectives of this type of education also involve being aware of the problem and the guidelines to follow, since the possible consequences of implementing the work at the curricular level represent different aspects related to social and environmental concerns (Maya, 1998).

If these measures were made effective, environmental education would be the cornerstone of planning in all contexts, taking into account the particularities of each specific area (Torres Consuegra, 1996). Some authors such as Monclus and Sabán (1999) have already established three alternatives in this respect: establishing cross-cutting themes as contents that establish a position—both individual and collective—in the face of environmental problems, relating the contents to values and attitudes that allow students to autonomously develop reflections which promote personal behaviors, and including the contents in the curricular areas that are already established.

Taking into account the aforementioned premises, the main objective of this study was to seek an educational improvement in the area of sustainability, as well as technology related to the CE and the reuse of MSW among pre-university students, for development of an educational intervention. In order to do this, action was undertaken on the two fundamental pillars of the CE: teachers and students.

From a Linear Economy to a Circular Economy

Since the first climate conference in Stockholm in 1972 (United Nations, UN, 1973)—better known as the First Earth Summit—and despite the conflicts caused between the governments of the various states due to economic interests, international concern for the environment has grown in relation to technical, demographic, and cultural issues (Boudes, 2011). This first "soft legislation" regarding international issues related to the environment was the beginning of certain shifts towards new, "greener" models of action. Thus, based on unacceptable economic and social growth, the participants agreed on a series of principles and recommendations for action at the international level, because it was understood that coordinated work between the socioeconomic and environmental dimensions would allow sustainable development and environmental awareness to be related effectively, as long as internationally integrated structures were promoted, such as:

- planning and management of human settlements from the perspective of environmental quality (Recommendations 1 to 18);
- the organization of natural resources and their relationships with the environment (Recommendations 19 to 69);
- pollutants at the international level (Recommendations 70 to 94);
- educational, informational, social, and cultural aspects related to the environment (Recommendations 95 to 101);
- development of the environment (Recommendations 102 to 109).

All these recommendations pointed to "the limits of economic rationality and the challenges generated by environmental degradation to the civilizing project of modernity" (Leff, n.d., fourth paragraph).

Similarly, this space provided the raw material for the development of an intellectual, moral, social, and spiritual vision regarding the environment, because it was understood that there was a need for consumer habits to change to prevent the destruction of the ecosystem from becoming irreversible (Ramírez, Sánchez, & García, 2004).

All of these ideas are implicit in the concept of the CE, as contended by Pearce and Turner (1990), who demonstrated the impact that the economy of the time had on the environment, analyzing the linear economic model and its effects. In the same vein, Stahel and Reday (1981) understood the economy as a circular system with a constant flow of materials, which allowed maximum care of spending, facilitating the creation of new jobs and improving efficiency by innovating in new technologies. Understanding the scope of these views, the European Community was one of the world forerunners in adopting these types of measures, creating the first *Environmental and Consumer Protection Directorate*, and the first Environmental Action Program (1973), the result of which was the *Green Book* as a tactic to moderate waste produced from fossil fuels (European Commission, 2013).

As a concept, we can say that the CE is an economy capable of taking advantage of the durability of products, which promotes eco-consumption, reuse and repair, recycling of waste, the market for secondary raw materials, as well as "new models of business such as industrial ecology, territorial symbiosis, the economy of functionality, the collaborative economy, etc." (Economía Circular, 2017, p. 5).

This is therefore in contrast to the current linear economy of extraction, manufacture, consumption, and disposal, since the three principles of the CE are: conservation and improvement of natural capital; optimization of returns on resources; and promotion of the efficacy of the system. This is only feasible if there is regeneration, sharing, optimization, creation, virtualization, and appropriate use of waste to allow an economic boost that supports the productivity of resources, promoting natural capital and its resilience (Webster, 2017). These are terms that are clear even to children (Fernández, 2018), but which are not usually practiced, because to do this a regenerative and ecocentric posture must be assumed that acts on specific aspects that prevent this change in mentality (Sandoval-Ruiz & Ruiz-Díaz, 2019). This includes, for example, improving the quality of products and efficiency in the sale and recycling process (Stahel & Reday, 1981) and generally following a series of fundamental precepts such as: the design of waste prevention, building resilience through diversity, use of renewable energies, waste is food, systems thinking, waterfall thinking, and a focus on performance (Fundación COTCE para la Innovación, 2019).

However, harmonizing human actions and economic growth with the protection of the environment is not a simple challenge, since the dominant paradigms that are most damaging must be broken so environmental rationality inevitably involves becoming human beings that are integrated with nature (Leff, 2004).

From this perspective, increasing social awareness to change the current economic model will directly encourage more appropriate use of urban waste and, thus, the generation of new products with high added-value on the part of social agents (citizens, institutions, etc.).

Raising awareness, educating, and building in the CE and MSW

Educational experiences in the recycling of plastic, glass, wood, or cardboard have been developed extensively by various organizations (Apud Porras, 2012; Ecoembes.es, n.d.), and universities (Wadel, Pérez, Giacomelli, Scheffer, & Pascual, 2018).

In contrast, MSW has so far had a smaller impact in the media and, therefore, there are fewer actions to promote citizen awareness. This situation diverges from the urgent need to achieve a change in the way that this kind of waste is treated, as reflected in all the regulations that have been developed in the field of our research and which are being shaped in European, national, and regional laws (Centro para el Desarrollo Tecnológico Industrial, CDTI, 2016; España Circular 2030, 2018; Gobierno de España & European Commission, CE, 2017; Ley de Economía Circular de Castilla-La Mancha, 2019).

On the other hand, it is obvious that a good CE strategy inevitably involves making great efforts in the area of information, awareness, and education, and that these efforts should also be aimed at all types of publics (Economía Circular, 2017). It is therefore essential to develop pilot projects (Fernández-Cézar, Pinto-Solano & Muñiz-Hernández, 2018) through educational actions in initial training centers (elementary and secondary), in which tasks are implemented to raise awareness, such as reducing consumption (raising awareness about the ecological cost of making a product) or taking advantage of waste recycling, giving it a new added value, which would allow us to see the enormous possibilities that the bioeconomy has in the place where one lives (Buckland, 2007). This can be observed in the case of Castilla-La Mancha, which, being a community largely focused on agricultural production, "generates a significant contribution to the emission of greenhouse gases, which is increased with disposal and generation of waste, as well as the loss of organic matter for the soil" (Avilés Pozo, 2018).

The CE and education

As we have already mentioned, the CE is in contrast to the linear economy. For this reason, one of the proposals of the European action plan is to provide economic incentives to manufacturers of green products and to support recovery and recycling. Despite the effort, the possibility of improving processes and orienting them towards the CE rests upon the education system and thus training people with the necessary skills to be familiar with the processes and resources related to the CE and who will study subjects in science, technology, engineering, art, or mathematics (STEAM).

As far as we know, there are no pre-university educational programs in Spain that involve studying the CE. Similarly, in the Spanish university-level education system (degree, master's, and doctorate) the training offering varies from a single course to a complete master's degree and they include very general coverage of the subject, without analysis that addresses the specific potentialities of the regions (Ruiz-Pastor, Mulet, & Chulvi, 2018). There is, therefore, a recognized need to increase the presence of the CE in STEAM studies and in the education system at lower levels, as well as to increase the training offering in the different regions in terms of the aspects that the CE implies in each area and the green employment possibilities that its implementation entails.

We believe that it is important to develop STEAM training programs or actions at the pre-university level that consider the CE, since early knowledge promotes its assimilation and can have an impact on the choice of subsequent studies. On the other hand, we also consider it essential for these actions to be carried out in

contrasting manners in rural and urban settings, since social relations are very different in these contexts (Salvia, Andreopoulou, & Quaranta, 2018), and it is also known that adolescent students have more stereotyped perceptions than other populations, typical of this time of their lives (Barth, Kim, Eno, & Guadagno, 2018; Stadler, Baganz, Vermeulen, & Keesman, 2015), which are fueled by the conceptions that rural school teachers have about science, as reported in a study by Ruiz Medina, Parga Lozano, and Martínez Pérez (2009). However, with these students, we also have time to generate a change in their perceptions, which are not yet fully formed and are more susceptible to being modified than those of adults.

Instruments to measure perception or awareness

Despite the limited scientific literature on awareness of the CE, there are several questionnaires on perceptions and appraisal of the environment. So we found various instruments with confirmed psychometric properties, such as the *Encuesta de ecología y medio ambiente* (Survey of ecology and environment) from the Ministry of the Environment (2010) and the *New Environmental Paradigm Scale*, which includes 16 beliefs about humanity's relationship with the planet and the impact of its activities on it (Dunlap, Van Liere, Mertig, & Jones 2002; Vozmediano Sanz & San Juan Guillén, 2005). In spite of this, none of these studies include a predictive analysis regarding recycling behavior in the subjects studied, which is the case in the *Cuestionario sobre la conducta de reciclaje basada en la conducta planificada* (Questionnaire on recycling behavior based on planned behavior) (Aguilar Luzón, García Martínez, Monteoliva Sánchez, & Salinas Martínez de Lecea, 2006), where the measurement of the variables of the model of value, norms, and beliefs (VNC) towards the environment and the theory of planned behavior (TPB) are used, an important aspect to be able to discern what one thinks should be done, or the discourse and actions that would later be consciously carried out.

Previous research on the CE and education

There is little scientific literature in which efficient work has been done on raising awareness of the CE. Some recent studies that we echo can be found in research that has been conducted in nations such as China, Finland, or Italy on how to begin moving towards sustainable development (Guo & Zhang, 2014). The most important inference—with these studies agreeing on this—is that despite having sufficient potential and infrastructure to develop good environmental policy, these efforts may not be successful if the basis for this growth is not quality environmental education from the base itself up to the global level, in such a way that it can be established as a transversal value (Åhlberg, Aineslahti, Alppi, Houtsonen, & Nuutinen, 2014; Chen & Chen, 2019).

Other studies have been aimed at the creation of gamified materials, such as the board game *In the Loop*, which enables learning about the major concepts of the CE and the sustainability of raw materials (Anderberg & Thisted, 2015; Whalen, Berlin, Ekberg, Barletta, & Hammersberg, 2017).

Objectives

Considering the educational situation described above, the following objectives were set out in this study:

- Measure the level of awareness regarding the CE among non-university teaching staff.
- Determine the type of action that would be necessary in education.
- Present a teaching intervention to contribute to the knowledge and awareness of these teachers.

Methodology

The methodology used in this research was quantitative with non-probability sampling in terms of measuring the level of awareness of non-university teaching staff, and qualitative as regards determining the type of action required and the design of the comprehensive teaching intervention.

In order to achieve the first objective, we used a questionnaire based on that developed by Sánchez-Emeterio and Figueira (2019), to which we added terms related to the circular economy in which we considered the level of interest in the CE on the part of non-university teaching staff, along with the number of enrollees in a course offered by the Regional Center for Teachers (CRFP) in Castilla-La Mancha, Spain, and the number of those teachers who completed the questionnaire and their responses. Based on these selective criteria, there were 50 participating teachers who enrolled in the course and 32 of them completed the questionnaire, which ended up representing the sample for this study.

Of these 32 teachers, 23 were women and seven were men, and two did not state their gender. With regard to the educational stages in which they practiced their profession, five of them were pre-school teachers, five worked in elementary education, and the remainder worked in secondary education; 20 of them taught science classes and two taught economics subjects (Figure 1).

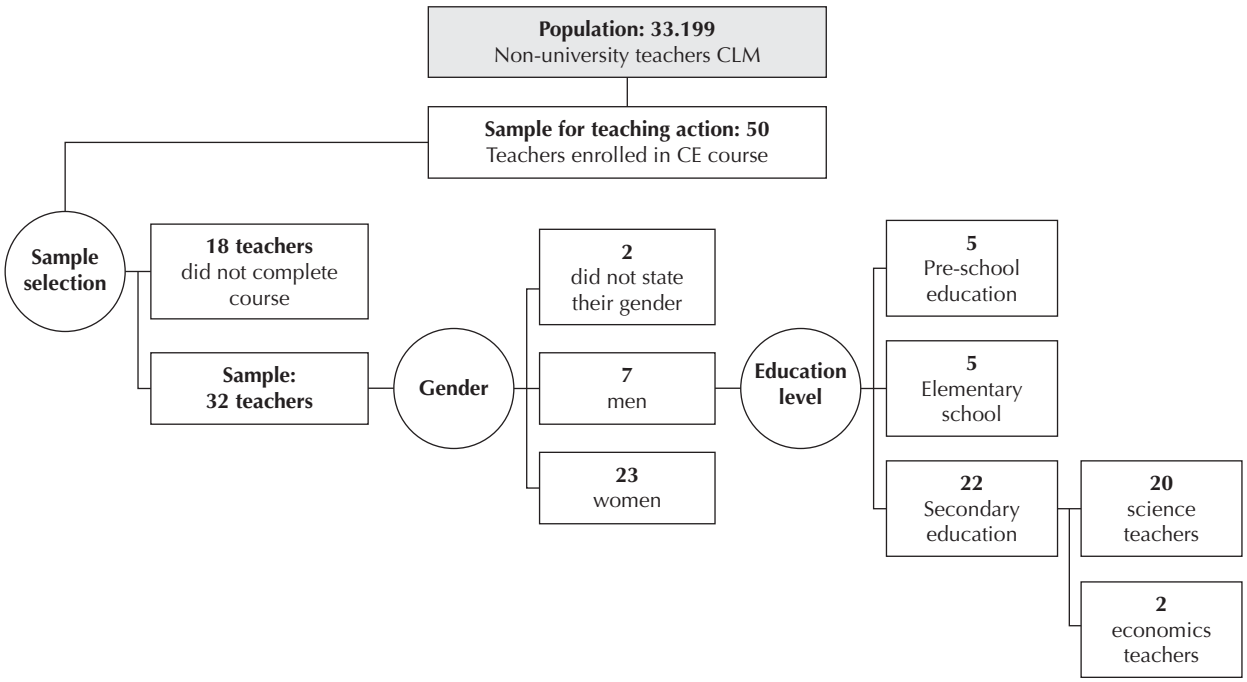

Figure 1. Flowchart showing the section process for the sample.

The questionnaire used included questions about the teacher's concern about the environment and their knowledge of certain issues related to the CE, such as: "On a scale from 1 to 5 where 1 = *not at all concerned about the environment* and 5 = *very concerned*, how would you generally consider yourself?"

The terms on which the teachers were consulted were: the CE, ecosystem, linear model of production-consumption, sustainable development, economic decline in production and consumption, overexploitation, pollution, water cycle, recycling cycles, climate change, low consumption applications and programs, gasification, sustainable chemistry, eco-social literacy, glass recycling, zero energy consumption building, sustainable food systems, sustainable food production technology, and hydrogen electrocatalyst.

In order to achieve the two remaining objectives, we used the technique of a focus group of experts. Their results, along together with those obtained in the questionnaire, by means of triangulation, served to carry out an overall teaching training intervention and dissemination with the aim of raising the awareness of the teachers included in the study regarding the concepts of the CE and so they, as a consequence, would serve as transmitters of this knowledge in their classrooms.

Results

Analysis of questionnaire

With regard to the interest and concern shown by the teachers regarding the topic studied, 43.75% declared themselves to be very concerned, 40.63% said they felt concerned, and 12.5% said they were somewhat concerned, while none of them stated that they were almost or not at all concerned.

In terms of their knowledge about the concepts related to the CE, the teachers stated that the term most unfamiliar to them was "hydrogen electrocatalyst", followed by "sustainable chemistry". The terms that the majority of teachers indicated that they knew little about were: the "circular economy", the "linear production-consumption model", "economic decline in production and consumption", "low consumption applications and programs", "gasification", "eco-social literacy", "zero energy consumption building", "sustainable food systems", and "sustainable food production technology". Finally, the terms that they indicated they were very familiar with were: "ecosystem", "sustainable development", "water cycle", "pollution", "overexploitation", and "recycling cycles".

The teachers declared themselves to be more knowledgeable about the terms that are more general, perhaps because they are already part of the vocabulary of practically all citizens, as they are more common in the media. In contrast, they stated that they were unfamiliar with specific technologies such as the hydrogen electrocatalyst, and somewhat more familiar with technologies related to food and recycling (Figure 2).

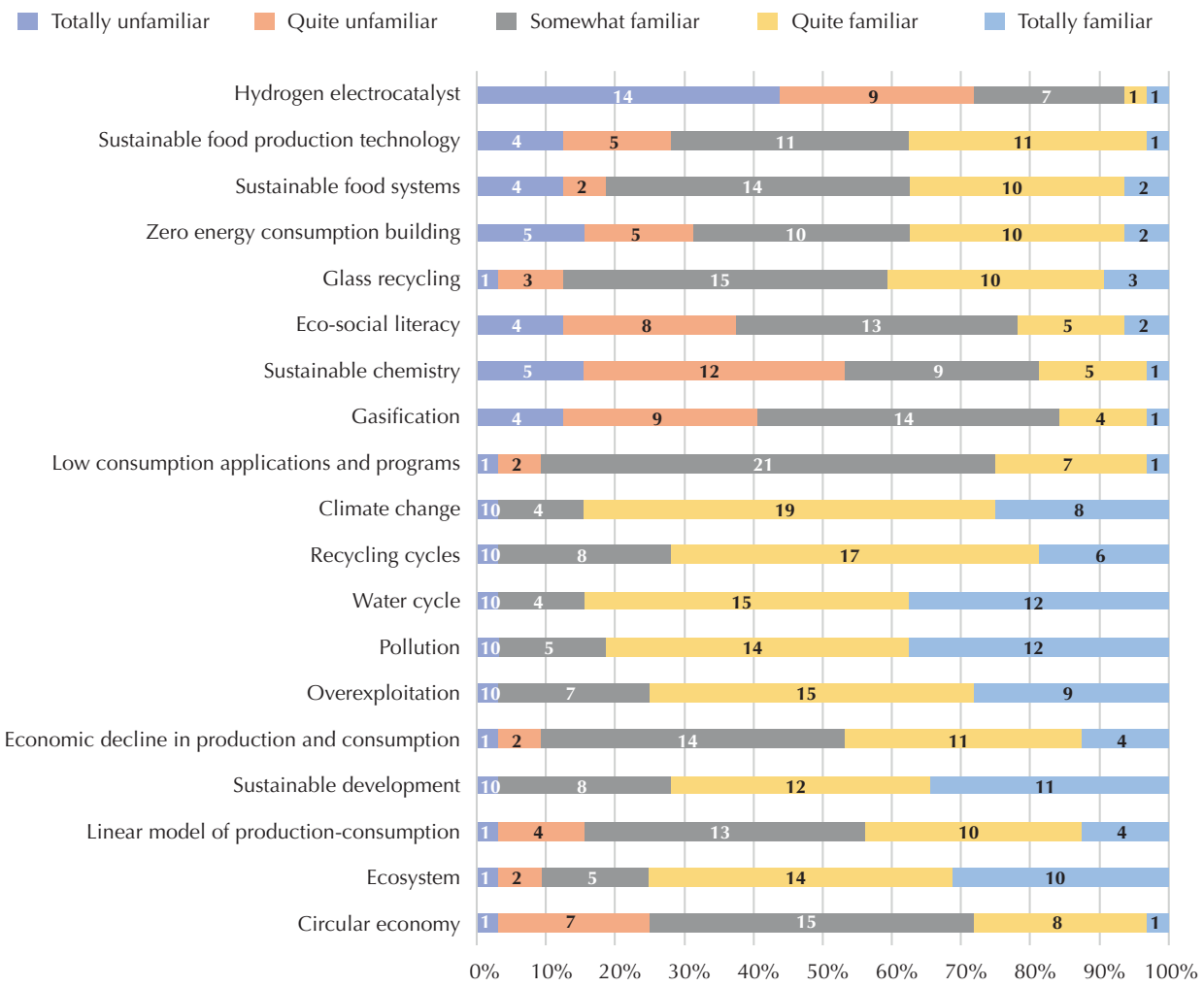

Figure 2. Degree of participating teachers' knowledge of terms related to the CE.

Analysis of focus group

All of the experts participating in the focus group (five) have worked as teachers employed at universities and working in the field of education in different areas. Therefore, they were a multidisciplinary group with experience in issues related to the environment.

Based on the analysis carried out, we obtained the type of actions that are necessary at the educational level.

The analysis by the group of experts was focused on four topics of discussion: adaptation of content about sustainable development and the CE; educational measures to raise awareness and sensitize young people on this subject; more effective educational methodologies to raise awareness among students; and more effective types of digital resources to work on these types of topics in the classroom.

The following table shows the points on which there was agreement between the experts.

Table 1
Analysis of the topics by the focus group of experts

Topic	Points of agreement	Disagreement
1 Curricular adaptation	• Curricular integration. • Interdisciplinary. • Globalized.	• Depends on the teacher whether they want to include the topic or not.
2 Educational measures	• Young people have to be reached, since there is a duality among them (aware and unaware). • Lack of connection between the institutions and their surroundings. • There is greater presence of educational actions regarding the CE in non-formal education. This type of action should be promoted in the area of formal education.	• Excessive responsibility upon the individual and not upon the communities ("eco-anxiety"). • Society destroys the critical thinking of students in light of this problem. • Awareness exists, but in specific areas (science). This has to be encouraged transversally.
3 Methodologies	• Active: Service learning, problem-based learning, game-based learning, problem solving. • Games as a strategy are essential (videogames, gamification). • Stories, excursions, workshops.	• Situational learning. • Open educational resources (OER). • Teaching based on practice to achieve conceptualization (learning by doing).
4 Resources and materials	• Videoconferencing. • Any resource in accordance with the learning style. • Videogames, social media (Tik Tok, Instagram).	• Augmented reality.

Source: Prepared by the authors.

Although there are certain disagreements, 100% of the experts advocated the inclusion of the concepts related to the CE in the classroom in a cross-cutting and interdisciplinary way, since they view this as not being a problem that concerns a curricular subject or area, but the educational dimension should instead be approached in a comprehensive way.

In terms of the educational measures to be taken, the responsibility of the school with regard to this type of problem is clear (80%). The information that reaches the student through the media (internet) is not always positive, as there is a clear duality between the students who are most aware and those who are not. Similarly, family environments are often a reflection of a society that is not very conscientious and supportive, so it will ultimately be the school that will provide responses and solutions to this deficiency, creating critical and responsible citizens.

The term "eco-anxiety" draws the attention and, although not all of the experts point to it as a problem (60%), it has taken on increasing relevance, even being considered as a possible disorder that the American Psychological Association defined as "A chronic fear of environmental doom" (Whitmore-Williams, Manning Visiting, Krygsman, & Speiser, 2017, p. 68).

The experts also recognize that active methodologies are more effective than other teaching strategies. All of them backed learning based on problems or inverted classes, while 80% favored the use of gamification. Finally, 60% were interested in open educational resources (OER), as well as situated learning. In this respect, despite the fact that classrooms have advanced technology, there is still some suspicion among teachers about using certain more innovative techniques.

Lastly, in terms of resources, the experts believe that those linked to methodological strategies, should be used based on the student's learning styles and there is a majority consensus regarding the use of videoconferencing as a resource to achieve this aim.

Educational intervention

Based on the main objective of this study, which was to seek educational improvement in the field of sustainability, CE-related technology, and the reuse of MSW among pre-university students, the following teaching and innovation objectives were outlined for the development of the educational intervention:

- To contribute to the knowledge of Spanish scientists in the field of the CE.
- To be familiar with the degree of awareness and knowledge of teachers about the elements that comprise the CE.
- To promote proactive awareness of students regarding this topic through gamification activities (competition).
- To promote the use of teaching materials by teachers aimed at raising awareness of the CE.

At this stage of the intervention, the preparation of the work entailed three main actions: the creation of a web environment and audiovisual materials, creation and implementation of a teacher training course, and a competition involving videos about the CE.

Action1: Creation of a web environment and audiovisual materials[1]

The audiovisual material created for the project consisted of 10 interviews with female scientists dedicated to research related to the CE. Each meeting was carried out in the form of a didactic video (Gértrudix, Rajas, Barrera, Bastida, & Soto, 2017) and with a set structure: presentation; life stories about how and why they became researchers, their motivations, their most important lines of research, and which of them were linked to the CE, emphasizing the chemical elements they use and which are involved in it, and personal views about equality and parity for women in research and science.

1. All of the content of the intervention, along with the resources created, can be seen at the following link: https://cienciacreactiva.bio3project.es/

Figure 3. Example of presentation of the videos of the female scientists interviewed.

Some 30% of the women interviewed were university lecturers, while 10% worked in companies, and 60% worked as researchers at the Center for Scientific Research, CSIC. All of them were responsible for research projects and only 30% of them were the directors of those projects. Their main topics of research include the following: waste recovery in the home, development of software and apps, drinking water, eco-social awareness and literacy, glass recycling, design of buildings with low energy consumption, food industry, hydrogen chemistry, prepared food, and gasification of organic products.

Action2: Creation and implementation of a teacher training course

The methodological design (blended learning) used for the course focused on the idea of microlearning, that is, "small units of content and design of short-term learning activities" (Santiago, 2015, first paragraph). The structure of each unit or module (Figure 4) thus consisted of a brief introduction to reading documents and a series of activities that helped with understanding the content.

¿Cuál es la estructura del curso?

Módulo	Descripción	Modalidad	Fecha
Módulo 1: Presentación del curso.	Presentación presencial del curso. ¿Qué es la economía circular y qué puede aportar a la sociedad?	Presencial En las sedes de los centros de formación	Tercera semana de febrero
Módulo 2. Mujeres científicas en la economía circular.	Vídeos didácticos sobre el trabajo de mujeres científicas en ámbitos de sostenibilidad y/o a economía circular.	On-line	Marzo
Módulo 3. La voz de los expertos en educación sobre la economía circular.	Vídeos didácticos de expertos abordando distintos tópicos sobre economía circular: Tema 1. ¿Es adecuada la incorporación de los contenidos de desarrollo sostenible y economía circular en el currículo de primaria y secundaria? Tema 2. ¿Qué medidas educativas se están desarrollando para concienciar y sensibilizar a los jóvenes en esta materia? Tema 3. ¿Qué metodologías educativas son más efectivas para provocar una sensibilización en los estudiantes? Tema 4. ¿Cuáles son los recursos digitales más eficaces para trabajar en el aula este tipo de temáticas y provocar una mayor sensibilización y concienciación?	On-Line	Marzo
Módulo 4. La voz de los estudiantes sobre la economía circular.	Elaboración de una Unidad didáctica y un vídeo donde quede reflejado parte del conocimiento del curso adquirido por los participantes y sus estudiantes.	On-line	Abril
Módulo 5. ¡Participa en el concurso de videos didácticos sobre economía circular.	Concurso sobre el vídeo realizado en el módulo 4. Aunque no es obligatorio, los docentes, junto a sus estudiantes podrán participar en el concurso subiendo a la web del proyecto el video correspondiente.	On-line	Mayo

Figure 4. Modules and content of teacher training course.

Action 3: Video competition on the CE

The main factor to achieve the objective of raising awareness about the CE is to give the students a voice through their own products, which has been assessed by Gavilondo Rodríguez (2016) regarding the student's interest in the video to visualize their work better.

The competition was therefore aimed at having the students participate, along with their teachers, to create videos about the CE, women in science, and chemical elements. In order to select, assess, and present awards, we considered the quality of the gamification, the format, and the content with which they worked (Gértrudix et al., 2017).

Figure 5. Poster and pamphlet to promote the competition.

Unfortunately, due to the COVID-19 pandemic—and because education centers in Spain were working with online education—the awards were presented via videoconference.

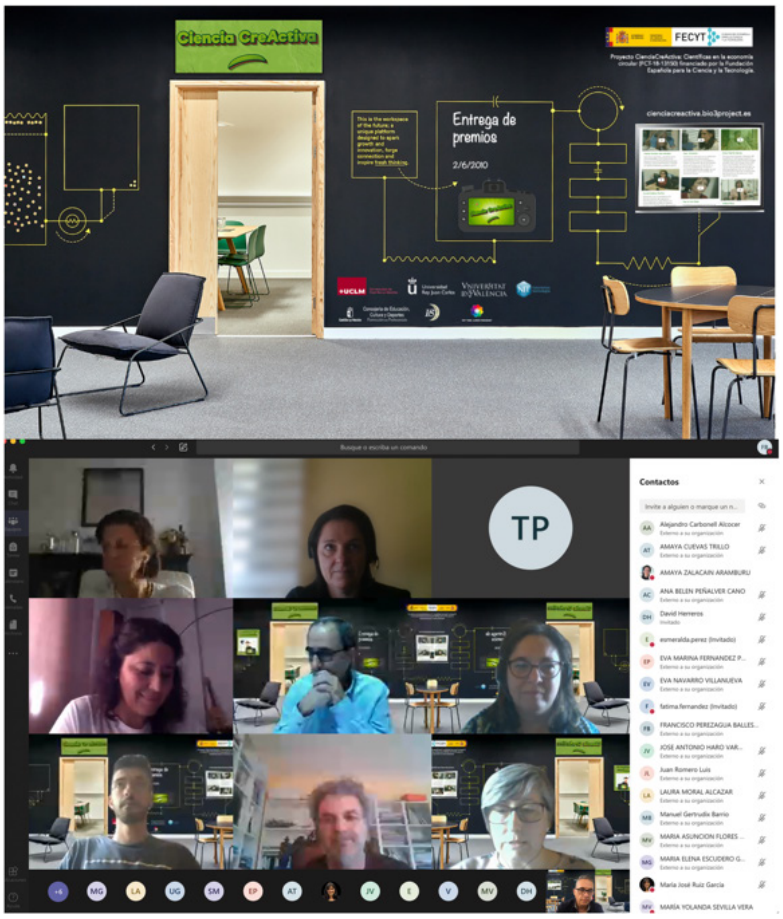

Figure 6. Virtual presentation of awards.

Conclusions, Discussion, and Outlook for the Future

Strategies for transition

Throughout this paper we have been able to demonstrate the need for a paradigm shift in the system of production and consumption. In order to have a solid base on which to build a long-term project, it is essential to have a favorable international framework that allows and promotes the development of research that advocates for this change (European Commission, 2014; European Commission, 2017).

Nevertheless, various authors have shows that cultural barriers prevent the CE from moving on from being a discourse for the minority to a generalized idea (Canal Vieira & Gonçalves Amaral, 2016; Kirchherr et al., 2018). As Enrique Leff (2017) states, political ecology must be constructed on the basis of diversity "through a policy of difference and an ethic of otherness. This is the view that opens up the creative dialogue between the regional political ecologies of the world that converge with and are traversed by their power strategies"

(p. 251), that is to say, a political epistemology which must address profound study of the "knowledge of cultures about their social and productive organization, about their relationship with nature, and with the dominant economic order" (Leff, 1998, p. 233).

We live in a world dominated by neoliberalism that responds more to a type of political strategy than to the underlying economic imperatives, so we have to seek an environmental rationality in which cultural diversity is given primacy, "the over-economization of the world is being questioned, the excessive reifying rationality of modernity, the excesses of objective and utilitarian thought" (Leff, 2004, p. X of prologue). In this respect, in 1971, Eduardo Galeano, in the essay *Las venas abiertas de América Latina*, commented that "the international division of labor consists of some countries specializing in winning and others in losing" (p. 15), a situation also criticized by the Canadian philosopher Naomi Klein (2000): "The Third World, as they say, has always existed for the comfort of the First" (p. 34), when she argues that Nike shoes, Barbie dolls, or Starbucks coffee are manufactured in the workshops of Vietnam, Sumatra, or Guatemala, thanks to neoliberalism and the prevailing globalization. Thus, far from finding ourselves in a situation of progress, with each year that passes we see ourselves with a more unequal world, where the gaps are not only technological, but where the otherness of the north compared with the south is also evident in scientific colonialism (Espinosa, 2020).

Considering all of this, implementing the model of the CE entails a great many challenges. These include changing mentalities, imposed paradigms, and the habits of modern consumerism, where the preference for exclusivity and authenticity undermine the CE principles of recycling and reuse (Hood, 2016).

Education for sustainable development

The study of recycling at all levels of education has proved to be an enriching experience. There has been an evident increase in interest to learn about and improve knowledge about environmental sustainability in recent years, since this type of education involves multidisciplinary learning in areas such as science, chemistry, mechanics, electricity, etc. However, the benefits go beyond the merely educational, because work on the importance of recycling and the effects of climate change goes beyond this, building towards the need for a paradigm shift that can allow renewed teaching regarding an alternative model, such as the CE.

We have experienced almost 50 years of ignored warnings based on the science despite an "emergency situation on a planetary scale" (EsXrebellion, 2019, first paragraph), and, although economic power is globalized and does not serve true environmental democracy as a political ontology where it is possible for "many worlds to live in this world" (Leff, 2017, p. 248), small educational actions such as those we have outlined can help young people understand the environmental rationalization to which Enrique Leff (2004) refers and thus identify that certain human actions damage not only our immediate environment, but also negatively affect the way of life of other peoples and contexts.

This awareness must begin at the earliest levels, where there are already examples of how to help recycling work in the classroom, since this creates awareness among individuals who, for the most part, have not had similar external experiences and who will have to deal with the long-term impacts in the future.

Resources and materials to raise awareness and for change towards a CE

We have been able to observe that there are certain resources and teaching materials that are more efficient when it comes to generating an educational improvement in knowledge and awareness about the CE among pre-university students. In this respect, the internet and advanced technologies help enhance the connection between the learner and the content, influencing human behavior and how to assess changes in behavior.

Persuasive design—which is based on influencing human behavior through a product's characteristics—is capable of promoting certain objectives of sustainable development such as, for example, the control of food wastage as a way of regenerating economic and environmental development (Fogg, 2009).

Another aspect is gamification, which is based on the notion that enjoying a game is an effective way of learning (Singer, Golinkoff, & Hirsh-Pasek, 2006). This educational resource makes it possible to erode differences and make the objective closer and more real in the implementation of environmental education, for instance, with virtual reality, since there is evidence that this can generate changes in students' behavior (McComas, 2002).

Education as a value for the future

In light of the constraints in the transition to the EC, the school could hold the key to a sustainable future in which the consumer model is more respectful to the environment and more concerned about the planet (Buckland, 2007). We have been able to demonstrate this in the Ciencia CreActiva project, where the value of the products created by the students and guided by their teachers have generated positive conscience and awareness regarding the elements of the CE studied. Work with these kinds of realities in education can gradually form critical citizens who have an ecological conscience that allows us to advance towards the future.

On the other hand, the teacher has to be the best guide to help effect change and raise the awareness of their students by creating the desire to learn (Jay, 2014), which implies obtaining specific training in current topics that will help them continue with their teaching work and, therefore, they will contribute clearly to guiding their students on topics such as the CE (students expect the teacher to give—or teach—them things that they cannot find on the internet).

In addition, the work and educational actions regarding a specific element such as that discussed in this paper promote coexistence (Valencia Torres, González Suárez, & Valencia Torres, 2017) between the participants of the pedagogical activity, since they live with each other on the basis of a series of social relationships and codes (Rodríguez & Vaca, 2010), learning from their own experiences and those of others, thus promoting critical development, care, and co-responsibility (Vilches, Gil Pérez, Toscano, & Macías, 2014).

In the project we have been able to provide an account of how a comprehensive intervention in the classroom helps to improve awareness and knowledge about the elements of the CE. In spite of this, we still do not know the effects that this could have in the medium and long term.

Similarly, we know that there are certain factors that hinder standardized integration of content such as that we have presented here, including the existence of a closed curriculum, poor teacher training, an almost total lack of interdisciplinarity and, therefore, of a model of hourly scheduling and atomization of content. All things considered, we need to move towards critical and sustainable action over time where students understand the problem as an opportunity for the future, analyzing all perspectives, since it is common that—as in the case of diseases—people have as much fear of the vaccine as the disease itself: eco-anxiety versus "business as usual" (Sáez, 2019).

This situation creates the need to propose an interdisciplinary project, since the necessary flexibility does not exist to do this holistically, as could be allowed, for example, in the early childhood education system, which could be the object of study due to its versatility and the capacity of the students to become aware and conscientious (Brenes Gómez, 2016). For this reason, continuity in the process, with new challenges and involving a greater number of teachers and students, could ensure consolidation of the project and, above all, based on integrative, interdisciplinary, inter-level, and transversal teaching work, since this is an issue that is important to everyone, so we should all be part of it.

"Turn a tree into a log and it will burn for you, but it will never bear living flowers and fruit." (Rabindranath Tagore)

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References

Aguilar Luzón, M. C., García Martínez, M. A., Monteoliva Sánchez, A., & Salinas Martínez de Lecea, J. M. (2006). El modelo del valor, las normas y las creencias hacia el medio ambiente en la predicción de la conducta ecológica. *Revista Internacional de Psicología Ambiental, 7*(2), 21-44. Retrieved from https://cutt.ly/iyZBGNB

Åhlberg, M. K., Aineslahti, M., Alppi, A., Houtsonen, L., & Nuutinen, A. M. (2014). Education for sustainable development in Finland. In R. Jucker & R. Mathar (Eds.), *Schooling for sustainable development in Europe* (221-239). Springer Link: Luxemburg.

Anderberg, M. & Thisted, S. (2015). *Swedish waste streams in a circular economy-a study of the perception change of waste flows when reviewing waste recycling target for the EU proposed circular economy package* (Master thesis). Lund University, Lund.

Apud Porras, A. (Ed.). (2012). *El consumo responsable en centros educativos. Red Valenciana de Educadores y Educadoras para la Ciudadanía Global.* Retrieved from https://cutt.ly/wyXrAOS

Avilés Pozo, A. (31 de julio de 2018). Castilla-La Mancha inicia la batalla legislativa contra el desperdicio alimentario. *El Diario.es* (s/p). Retrieved from https://goo.gl/Ss9Sz1

Barth, J., Kim, H., Eno, C., & Guadagno, R. (2018). Matching abilities to careers for others and self: Do gender stereotypes matter to students in advanced math and science classes? *Sex Roles, 79*(1-2), 83-97. https://doi.org/10.1007/s11199-017-0857-5

Bio3 (2020). Ciencia CreActiva. Retrieved from https://cienciacreactiva.bio3project.es

Boudes, Ph. (2011). United Nations Conference on the Human Environment. In J. Newman (Ed.), *Green ethics and philosophy-the green series: Toward a sustainable environment, Vol. VIII* (pp. 410-413). London: Sage publications.

Brenes Gómez, E. (2016). *Educar para el consumo responsable en la etapa de infantil. Una propuesta metodológica desde la sostenibilidad.* (TFG). Retrieved from https://goo.gl/yDVHzn

Buckland, H. (Ed.) (2007). *"Piénsatelo bien". Reflexiones sobre el papel de la educación para un consumo más responsable*. Barcelona: El Tinter. Retrieved from https://goo.gl/DiuYX3

Canal Vieira, L. & Gonçalves Amaral, F. (2016). Barriers and strategies applying cleaner production: A systematic review. *Journal of Cleaner Production, 113*(1), 5-16. https://doi.org/10.1016/j.jclepro.2015.11.034

Centro para el Desarrollo Tecnológico Industrial, CDTI. (2016). *Horizonte 2020: Novedades y lecciones aprendidas*. Retrieved from https://cutt.ly/5gvUXZi

Chen, C. W. K. & Chen, Y. T. (2019). Informal education of aerosol science by animation. Theory and practice. *IOP Conf. Series: Earth and Environmental Science 373* 012002. http://dx.doi.org/10.1088/1755-1315/373/1/012002

Comisión Europea, CE. (2013). *Un marco para las políticas de clima y energía en 2030*. Retrieved from https://cutt.ly/WyLxwZM

Comisión Europea, CE. (2014). *Estrategias nacionales y regionales para la especialización inteligente (RIS3)*. Retrieved from https://goo.gl/v19hCW

Dunlap, R., Van Liere, K., Mertig, A., & Jones, R. (2002). New Trends in Measuring Environmental Attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP Scale. *Journal of Social Issues, 56*(3), 425-442. https://doi.org/10.1111/0022-4537.00176

Ecoembes.es (s/f) *¿Y si hacemos algo más?* Retrieved from https://goo.gl/nY9ha8

Economía Circular (2017). *Por qué y cómo desarrollar estrategias de economía circular en el ámbito regional.* Retrieved from https://goo.gl/YcPKnK

España Circular 2030 (2018). *Estrategia española de economía circular.* Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, MAPAM y Ministerio de Economía, Industria y Competitividad, MEIC. Retrieved from https://goo.gl/3SFDP4

Espinosa, C. I. (12 de agosto de 2020). El colonialismo científico, una realidad tenaz. *El Diario.es.* Retrieved from https://cutt.ly/Vd8ZRDD

EsXrebellion (2019). *50 años de advertencias desatendidas*. Retrieved from https://telegra.ph/50-años-de-advertencias-desatendidas-05-21

European Comission (2017). *Results of Horizon 2020 stakeholder consultation: Interim evaluation of Horizon 2020.* Retrieved from https://goo.gl/37apcA

Fernández, J. A. (16 de julio de 2018). ¿Sabes qué es la economía circular? Estos seis niños lo tienen claro. *El País (Proyecto Naturgy).* Retrieved from https://goo.gl/wvU9Lg

Fernández-Cézar, R., Pinto-Solano, N., & Muñiz-Hernández, M. (2018). ¿Mejoran los proyectos de divulgación con experimentación la actitud hacia las clases de ciencias? *Revista de Educación, 381*, 285-308. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=6518464&orden=0&info=link

Fogg, B. J. (2009). A behavior model for persuasive design. *Persuasive '09: Proceedings of the 4th International Conference on Persuasive Technology*. https://doi.org/10.1145/1541948.1541999

Fundación COTEC para la Innovación. (2019). *Situación y evolución de la economía circular en España. Informe 2019*. Retrieved from https://cutt.ly/ByZhE1G

Galeano, E. (1971). *Las venas abiertas de América Latina.* México, D.F.: Siglo XXI editores.

Gavilondo Rodríguez, C. (2016). La producción de videos científicos: un acercamiento teórico. *Alteridad, 11*(1), 254-264. Retrieved from https://www.learntechlib.org/p/195393/

Gértrudix, M., Rajas, M., Barrera, D., Bastida, M., & Soto, C. (2017). *Realización de vídeo educativo: análisis de la producción audiovisual de los MOOC de URJCx*. Madrid: McGraw Hill Education.

Gobierno de España & Comisión Europea, CE. (2017). *Pacto por una economía circular: el compromiso de los agentes económicos y sociales 2018-2020*. Retrieved from https://goo.gl/c7vEcj

Gudynas, E. (2015). Derechos de la naturaleza. Buenos Aires: Tinta Limón.

Gudynas, E. (2018). *Extractivismos: el concepto, sus expresiones y sus múltiples violencias. Papeles de Relaciones Ecosociales y Cambio Global*, *143*, 61-70. Retrieved from https://cutt.ly/qd8B2GY

Guo, P. & Zhang, X. (2014). Study on circular economy education in rural areas in China. *Proceedings of the International Conference on Logistics, Engineering, Management and Computer Science* (pp. 24-26). Paris: Atlantis Press. https://dx.doi.org/10.2991/lemcs-14.2014.213

Hood, B. (2016). Make recycled goods covetable. *Nature, 531*(special issue), 438-440. Retrieved from https://cutt.ly/fyXe83W

Inocêncio da Silva, R. P. & Ferreira Maia, F. J. (2017). A aplicação da extrafiscalidade à Política Nacional de Resíduos Sólidos examinada pela perspectiva de Enrique Leff. *Revista Acadêmica Faculdade de Direito do Recife, 89*(1), 50-71. Retrieved from https://cutt.ly/1d8Koep

Jay, M. (13 de marzo de 2014). Un docente debe crear deseo de aprendizaje. *Tiching blog.* Retrieved from http://bit.ly/Na1bdn

Kaplan, J. (2015). *Humans need not apply: A guide to wealth and work in the age of artificial intelligence*. New Haven: Yale University Press.

Klein, N. (2000). *No logo.* Toronto: Alfred A. Knopf.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics, 150*, 264-272. https://doi.org/10.1016/j.ecolecon.2018.04.028

Leff, E. (s.f.). *Globalización, racionalidad ambiental y desarrollo sustentable*. Retrieved from https://cutt.ly/wd8Zxfa

Leff, E. (1998). Saber ambiental, sustentabilidad, racionalidad, complejidad, poder. México, D.F.: Siglo XXI editores.

Leff, E. (2004). *La racionalidad ambiental.* México, D.F.: Siglo XXI editores.

Leff, E. (2017). Las relaciones de poder del conocimiento en el campo de la ecología política. *Ambiente & Sociedade, 20*(2), 229-262. Retrieved from https://cutt.ly/Gd9PoSM

Ley 22/2011, de 28 de julio, de Residuos y Suelos Contaminados. *BOE núm. 181, de 29/07/2011*. 1-52. Retrieved from https://cutt.ly/nyZgu7Y

Ley 7/2019, de 29 de noviembre, de Economía Circular de Castilla-La Mancha. [2019/11104]. *Diario Oficial de Castilla-La Mancha, 12 de diciembre de 2019*, 48437-48442. Retrieved from https://cutt.ly/JyZhUX2

Macedo, B. & Salgado, C. (2007). Educación ambiental y educación para el desarrollo sostenible en América Latina. *Revista Fórum de Sostenibilidad, 1,* 29-37. Retrieved from https://cutt.ly/Ggvv8JA

Maya, A. (1998). *El retorno a la tierra: introducción a un método de interpretación ambiental.* Bogotá: Ministerio de Educación-Ministerio del Medio Ambiente-Universidad Nacional de Colombia, Instituto de Estudios Ambientales.

McComas, W. F. (Ed.). (2002). *The nature of science in science education. Rationales and strategies.* Netherlands: Springer Nature.

Ministerio de Medio Ambiente (2010). Encuesta de ecología y medio ambiente. *Centro de Investigaciones Sociológicas (CIS).* Retrieved from http://www.cis.es/cis/opencm/EN/2_bancodatos/estudios/ver.jsp?estudio=11404

Molano, A. B. (2012). La complejidad de la educación ambiental: una mirada desde los siete saberes necesarios para la educación del futuro de Morin. *Revista de Didáctica Ambiental, 8*(11), 1-9. Retrieved from https://cutt.ly/Kgvbris

Monclus, A. & Saban, C. (1999). *Educación para la paz.* Madrid: Síntesis.

Organizaciones de las Naciones Unidas, ONU. (1973). *Informe de la Conferencia de las Naciones Unidas sobre el Medio Humano*. Estocolmo, 5 a 16 de junio de 1972. Retrieved from https://cutt.ly/gdEBULF

Pearce, D. W. & Turner, R. K. (1990). *Economics of natural resources and the environment*. New York: Harvester Wheatsheaf.

Ramírez, A., Sánchez, J. M., & García, A. (2004). El desarrollo sustentable: interpretación y análisis. *Revista del Centro de Investigación. Universidad La Salle, 6*(21), 55-59. Retrieved from https://www.redalyc.org/articulo.oa?id=34202107

Rodríguez, M. C. & Vaca, P. (2010). Promover la convivencia escolar: una propuesta de intervención comunitaria. *Aletheia, 33,* 179-189. Retrieved from https://www.redalyc.org/pdf/1150/115021494016.pdf

Ruiz Medina, D., Parga Lozano, D., & Martínez Pérez, L. (2009). Creencias de los profesores de preescolar y primaria sobre ciencia, tecnología y sociedad, en el contexto de una institución rural. *TED, 25*, 41-61. https://doi.org/10.17227/ted.num25-467

Ruiz-Pastor, L., Mulet, E., & Chulvi, V. (2018). *Análisis de la oferta educativa sobre economía circular en la educación superior española*. Retrieved from https://cutt.ly/XyZOYWL

Salvia, R., Andreopoulou, Z. S., & Quaranta, G. (2018). The circular economy: A broader perspective for rural areas. *Rivista di studi sulla sostenibilità, 1,* 87-105. http://dx.doi.org/10.3280/RISS2018-001008

Sánchez-Emeterio, G. & Figueira, C. (2019). Eco-social literacy: Circular economy conceptions in initial teacher training. *Proceedings of the 9th International Conference the Future of Education,* 486-490.

Sandoval-Ruiz, C. E. & Ruiz-Díaz, E. (2019). Eco-innovación en ingeniería de alimentos sostenible aplicando técnicas inteligentes de eficiencia energética-ecosveg. *Universidad, Ciencia y Tecnología, 22*(87), 54-66. Retrieved from https://cutt.ly/xyZhxwP

Santiago, R. (18 de mayo de 2015). ¿Qué es micro-learning? *The flipped classroom*. Retrieved from https://cutt.ly/KyXcDEv

Sáez, S. (2 de abril de 2019). Eco-ansiedad: ¿quién teme al fin del mundo? *Lamarea.com.* Retrieved from https://cutt.ly/Gd8VGeI

Seguí, L., Medina, R., & Guerrero, H. (2018). *Gestión de residuos y economía circular*. Retrieved from https://cutt.ly/vyZgvJq

Singer, D. G., Golinkoff, R. M., & Hirsh-Pasek, K. (Eds.). (2006). Play = learning: How play motivates and enhances children's cognitive and social-emotional growth. Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195304381.001.0001

Soto, M. (2018). *Humanidad necesita 1,7 planetas para satisfacer su ritmo de consumo*. Retrieved from https://cutt.ly/UyZgmKk

Stadler, M. M., Baganz, D., Vermeulen, T., & Keesman, K. J. (2015). Circular economy and economic viability of aquaponic systems: Comparing urban, rural and peri-urban scenarios under Dutch conditions. *Proceedings of ICESC2015: Hydroponics and Aquaponics at the Gold Coast*, *1176,* 101-114. https://doi.org/10.17660/ActaHortic.2017.1176.14

Stahel, W. & Reday, G. (1981). *Jobs for tomorrow, the potential for substituting manpower for energy.* New York: Vantage Press.

Tisserant, A., Pauliuk, S., Merciai, S., Schmidt, J., Fry, J., Wood, R., & Tukker, A. (2017). Solid waste and the circular economy: A global analysis of waste treatment and waste footprints. *Journal of Industrial Ecology, 21*(3), 628-640. https://doi.org/10.1111/jiec.12562

Torres Consuegra, E. (1996). *¿Cómo lograr la educación ambiental en tus alumnos?* La Habana: Ed. Pueblo y Educación.

Valencia Torres, M. A., González Suárez , E., & Valencia Torres, G. A. (2017). *Érase una vez una escuela que quería aprender a convivir… la versión de los profesores.* San Luis de Potosí: Congreso Nacional de Investigación Educativa.

Vilches, A., Gil Pérez, D., Toscano, J. C., & Macías, O. (2014). *Educación para la Sostenibilidad. Un compromiso renovado para la educación para la sostenibilidad.* Retrieved from http://www.oei.es/decada/accion.php?accion=2

Vozmediano Sanz, L. & San Juan Guillén, C. (2005). Escala nuevo paradigma ecológico: propiedades psicométricas con una muestra española obtenida a través de Internet. *Medio Ambiente y Comportamiento Humano, 6*(1), 39-47. Retrieved from https://cutt.ly/kyZBUjg

Wadel G., Pérez, L., Giacomelli, F., Scheffer, A., & Pascual; G. (2018). PRECO: Red Universitaria de Aprendizaje sobre Aplicación de Reciclados. *X Congreso Regional de Tecnología en Arquitectura (CRETA) (La Plata, 2018),* 284-293. Retrieved from https://cutt.ly/myZhRXV

Webster, K. (2017). *The circular economy: A wealth of flows*. Ellen MacArthur Foundation Publishing.

Whalen, K. A., Berlin, C., Ekberg, J., Barletta, I., & Hammersberg, P. (2017). 'All they do is win': Lessons learned from use of a serious game for circular economy education. *Resources, Conservation and Recycling*, *135*, 335-345. https://doi.org/10.1016/j.resconrec.2017.06.021

Whitmore-Williams, S. Cl., Manning, Ch., Krygsman, K., & Speiser, M. (2017). Mental health and our changing climate: Impacts, implications, and guidance. *American Psychological Association (APA).* Retrieved from https://cutt.ly/Sd8C958