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The Involvement of Future Generations in the Circular Economy Paradigm: An Empirical Analysis on Aluminium Packaging Recycling in Spain

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Abstract: The European circular economy action plan, launched in 2015 includes a group of measures aligned with the 3r principles. To meet recycling goals, valuable materials such as aluminium must have packaging that helps to increase their recycling rate above the current 45.6%. This recycling rate could be improved with the help of current consumers and the education of future generations. In this way, the aim of this study is to prove the positive effects of childhood education in the circular economy by teaching sustainable practices in the case of aluminium packaging recycling. The study was conducted in the form of a survey, with data being gathered via questionnaires carried out "pre" and "post" workshop in schools of different regions of Spain in students between 8 and 12 years old. This study provides an exciting opportunity to advance our knowledge of the use of workshops to increase children's knowledge, awareness, and intention of recycling.

Keywords: recycling; circular economy; environmental children education; aluminium packaging; social change

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1. Introduction

The environment has dramatically suffered the depletion of resources and biodiversity damage by the postmodern society [1] which is living in a linear economy system that consists of taking the resources, producing goods and services, and using and wasting them [2]. In contrast, the circular economy seems to be an alternative paradigm whose purpose is to prevent the depletion of resources and seek environmental regeneration through eco-innovative solutions and products that can be reintroduced in biological and technical cycles [3].

Moreover, the circular economy is usually associated with the 3Rs principle (reduce, reuse and recycle) according to authors like Wu et al. [4], Haas et al. [5] and Yuan et al. [6]. In this sense, Yong [7] affirms that "the 3Rs principle—well known as reduce, reuse, and recycle—is a good principle guiding how to implement the circular economy in practice". In this way, the implementation of circular economy facilitates that waste of some agents become valuable resources for others, achieving the recovery of materials and energy [8].

Specifically, the recycling component is one of the well-known priorities for the European Union which generates an average of 481 kg of household garbage by each person, each year. Thirty-one percent of this trash is placed in landfills, 26% is incinerated, 28% is recycled and 15% is composted [9]. In this way, recycling programs have to increase their effectiveness and become more popular among the community, thus, "long-term efforts such as intensified civic education and information strategies are needed" [10].

The circular economy implementation in our society could be facilitated through environmental communication campaigns regarding the stakeholders' perceptions [11,12]. Thus, based on the fact that some of the stakeholders' perceptions came from their education, this study considers the importance of environmental learning in children to modify the future behaviour of stakeholders. Besides, children are currently a strategic stakeholder [13] because they can act as prescribers at their homes and transmit "recycling culture" to their families and their environment [14]. Despite the high effectiveness of environmental education in young people [15], there has been little discussion about their current knowledge and opinions about nature and environmental issues [16].

Then, based on the fact that abstract based concepts of sustainability are quite complex to be understood by children, trainers have to look for ways to make it easier and more tangible [17]. Consequently, this work proposed to teach the circular economy challenges with the analysis of a well-known material that children can identify with easily, aluminium. The importance of aluminium in this study is based on three factors: it is valuable, its recycling rate is included in the CE action plan, and children can identify it easily.

First, aluminium could be considered a valuable material because it can be recirculated in value chains indefinitely without losing quality. Second, European legislation about circular economy demands higher recycling rates (75% in 2025) and aluminium must be increased 30 points considering that in 2016 it had a recycling rate of 45.6%. Moreover, when aluminium products are manufactured with recycled aluminium, only 5% of the energy is needed to get the same products which are produced with bauxite [18].

Third, this study considers that children training in aluminium packaging recycling could be a key issue because they represent the section of the market who consume products that are packed with this material such as beverage cans. It is interesting also to consider that a lot of sandwiches or snacks that children bring to school are wrapped in aluminium foil. In spite of the fact that aluminium foil is not considered packaging for the legislation, it might be perfectly recycled when it is deposited in the yellow container. This aspect is very important since previous research has found that a high percentage of young people usually think that the yellow container is only for plastic packaging [19].

For all these reasons, this study aims to prove the positive effects of childhood education in the circular economy by teaching sustainable practices in the case of aluminium packaging recycling. Thus, this study has been detailed in the following research objectives:

1. Define the level of knowledge that children have packaging recycling in general; and recycling of aluminium packaging, in particular.
2. Know the level of awareness that children have about recycling.
3. Identify the children's intention to recycle in the future.

After this introduction, we provide an overview of the circular economy and describe the literature on the recycling of packaging in Spain and Europe. Next, we describe our methodology and results. Finally, we offer some overall conclusions and broader implications for future research [20].

2. Education for Achieving the Circular Economy and Sustainable Development

Governments and political institutions, firms, consumers, and researchers have risen in defence of sustainable development. The 1980 World Conservation Strategy introduced the term "sustainable development" and the World Commission on Environment and Development develop the concept, providing what has become the most commonly used definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [21].

Moreover, the multidimensional understanding of sustainable development, which includes sustainability in the environment, society and economy [22], and time [23], is consistent with the need of closing energy and material flows. The most recent proof of this fact is that some of the 17 "Sustainable development goals" [24] are closely aligned with the CE, such as "Clean water and sanitation—Goal 6", "Affordable and clean energy—Goal 7", "Sustainable cities and communities—Goal 11" and "Sustainable consumption and production—Goal 12". Those goals especially include topics like waste management, recycling, access to clean energy, the sustainable management and efficient use of natural resources, among others.

This claim is coherent with K.E. Boulding's proposal [25], who explained the importance of closing the loops of materials and energy to ensure the sustainability of human life against a linear or "cowboy" model that was used previously. The linear model consists of "use of resources-production of products-generation of garbage". The circular model is valued because it increases the efficiency in the use of environmental resources, it reduces the environmental pollution and it faces the contraction between resources scarcity, environmental pollution and economic growth [26,27]. In fact, the circular economy has been defined as an "industrial system which has the virtue of restore and regenerate by intention and design" [28]. Consequently, some firms have already implemented it into circular business models which emerged in the market and support sustainable development [2,29].

With the aim of expanding the business models based on the circular economy, the EU launched in December 2015 a "Circular Economy Package" (CEP) with the goal of motivating the world competitively, promoting sustainable economic growth and generating new "green" jobs [30]. Among the activities that are in the CEP, are the following: activities to reduce food garbage, enhance measures in the ecologic design to promote reparation, the durability, recycling and reuse of the products, and so on. The goal of these measures is to "close the loop" of the products' life through the promotion of recycling and the reuse of products at the end of their lives [31].

Lastly, the success of those sustainable development goals and CE Action Plans can only be possible and sustainable over time, if the society implicates the future generations in the actions required to achieve sustainable development. Therefore, schools and universities should include environmental education to teach children the values, behaviour, knowledge, skills and competencies required for a sustainable future [32]. For example, the International Baccalaureate® (IB), a non-profit educational foundation which offers respected programs of international education, has announced that they are collaborating with the Ellen MacArthur Foundation to embed systems thinking and a circular economy perspective into the IB curriculum [33].

However, there is a gap between knowledge and awareness and between the action of recycling as some authors have studied [34]. Providing only information could lead to action for citizens that are already motivated to recycle but do not know how to do it (being able to identify the right container, for example). On the contrary, citizens that are not motivated to recycle but could do it to "gain" something (a prize in a contest for example) [35].

Literature about the subject also agrees that environmental communication tools and campaigns could help in overcoming this gap when working with knowledge and awareness as in the case of ecolabels [36] or the workshops reported here [37]. Workshops at schools (curriculum integrated or not) are an excellent tool to disseminate the environmental issues and achieve awareness among children and to practice recycling actions.

2.1. Aluminium Recirculation: Spanish Context

As one component of the 3R principles, Circular Economy Package (CEP) suggests a recycling rate of 75% in 2025 and 80% in 2030 for each packaging material. Concerning the metals, this rate distinguishes between steel packaging and aluminium packaging. Until now, aluminium has been joined with steel when calculating the recycling rate; this means that aluminium has benefited from the high steel rates.

Beverage cans are the most common aluminium packaging and the most recycled. However, in Europe, there are differences among countries. Finland and Germany boast 99% recycling rates while Croatia has about a 12% recycling rate. Spain reached a recycling rate of 66% in 2015 [9].

The recycling system in Spain uses three containers at least: a green one for packaging made of glass, a blue container for paper and carton board and a yellow one for light packaging (plastic, metals and bricks). Some regions have also added a brown container for organic waste.

In Spain, the aluminium beverage cans market share had a sharp increase from 23% in 2014 to 44% in 2015 and to 50% in 2016 due the reconversion to aluminium of two Rexam factories (nowadays Ball company), in La Selva del Camp (Tarragona) and in Valdemorillo (Madrid) (Figure 1). Besides, the aluminium beverage cans recycling rates increased to 66% in 2015 [38] and the following year it decreased to 64.1% due to the higher amount of aluminium cans in the market [39]. However, it is still necessary to increase the recycling rate of all aluminium packaging to achieve the European circular economy goals before the year 2025.

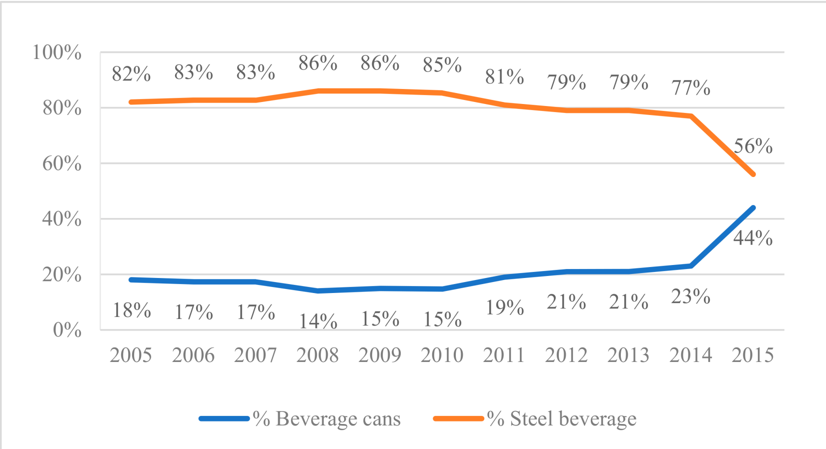

Figure 1. Percentage of aluminium beverage cans and Steel beverage cans in Spain 2005–2015. Own elaboration based on beverages cans, April 2017.

Currently, beverage cans have a market share of up to 70% in 2016, in Spain [39], but the recycling rate of aluminium packaging in general (not only cans) was 45.6% in Spain in 2016 [39]. Then, if we also consider the percentage that has gone from waste to energy, the rate reaches 48.3%.

In Spain, all of the packages in the market must be labelled with the "green dot", a symbol which means that the manufacturer has paid the recycling fee. In Spain, Ecoembes is the organization that manages the recycling of light packaging, paper, and cardboard. At present, there are over 12,000 companies affiliated to Ecoembes which process more than 1.7 million tons of domestic packaging placed on the market; this involves an investment of more than 400 million euros to enable their recycling [40].

Citizens deposit plastic, bricks and metal packaging in the yellow container. In 2016, 1.3 million tons of domestic packaging was recycled, which represented 76% of the containers which adhered to this Integrated Management System [41]. Regarding the "metal" (steel and aluminium packaging), the recycling rate reaches 84.8%. However, in differentiating the metallic materials (steel and aluminium), the latter reached a recycling rate of 45.6% and 48.3% of total recovery in 2016 [38] (Figure 2).

Despite the 10-point jump in the last 10 years, the recycling rate is far from the 2030 goal required by circular economy legislation (Figure 2). This issue should encourage the producers and consumers to increase their knowledge and awareness about the recycling of these packages. Moreover, the future European law about Circular Economy will ask to measure the recycling rate for both materials separately. Steel packaging is separated by magnets and almost all waste plants are provided by this technology. In the case of aluminium, it is separated by eddy current systems. In Spain, all sorting plants (where materials collected in the yellow container are conducted) have them but not all waste and compost plants do. In addition, some packaging made of aluminium is more complicated to separate from the waste stream due to its size or density.

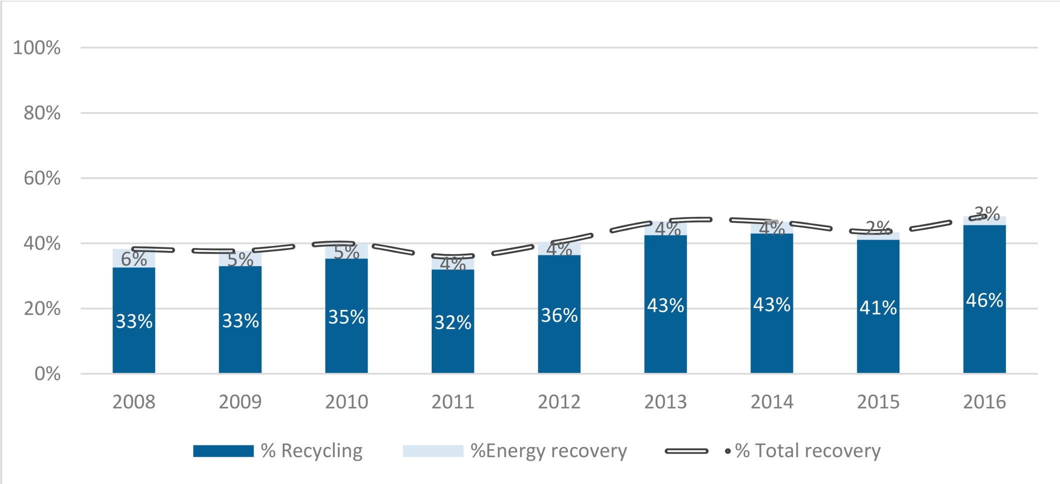

Figure 2. Total aluminium recovery by year. Own elaboration based on ARPAL 2016 [39].

2.2. Workshop Activities to Promote Recycling of Aluminium Packaging in Spain

ARPAL is the Association for the Recycling of Aluminium packaging and is responsible for promoting recycling and for packaging this material in Spain. It consists of the firms that operate this industry globally, some of them are Aludium, Constelium, Hydro Aluminium Deutschland GMBH and Novelis Europe. The association is also part of the Packaging Group of European Aluminium, which represents the associations allocated in all European countries.

One of the actions carried out by ARPAL is called "Direct Education". It consists of the training of trainers (teachers, leisure time monitors, and university volunteers) who then carry out workshops on recycling aluminium packaging in different regions of Spain, specifically in Andalusia, Catalonia, Castilla-Leon, Basque Country, Madrid and Islas Baleares, mainly aimed at children between 8 and 12 years. Other experiences like this one have proven to be very positive in order to promote actions regarding the environment [42].

The association began to carry out this activity in 2011 in Catalonia and it has extended to the rest of the regions mentioned above during these years. In addition, the participants receive a member card of the "Club I recycle aluminium" with the following "ALU commitment": "recycle the aluminium packaging in the yellow container and tell family and friends to do the same". As follows, trainers work with two awareness strategies in an effort to promote recycling [43]. On one hand, this club increases the feeling of belonging to a group and identifying with it (that of recyclers). On the other hand, the children commit to taking responsibility, and to recycling packaging and explaining what they learned to their family and friends. The commitment technique has proven to be very useful: a small initial commitment (such as the one proposed by the Club I recycle aluminium) can lead to greater and lasting commitments over time because the people who get engaged with it want to be seen as having continued with their commitment [44].

The Direct Education activity involves the relationship with local institutions and administrations, universities, Teacher Training Centers, Schools of Monitors, etc. In this way, the preparation of educational materials and the workshops have the same message, even though the educational resources are adapted to different levels and situations. The educational materials are elaborated by the association ARPAL and can be consulted at its page www.aluminio.org.

This awareness-raising work is relevant to achieving environmental awareness and action in the long term [10] and it collaborates with other instruments like policies oriented towards recycling or market-based incentives in increasing the recycling rate of packaging.

3. Materials and Methods

ARPAL proposed to school managers to develop workshops about aluminium packaging recycling to students from 8 to 12 years of age; the project was well received. The workshops were developed with a children profile to build sustainable habits in future generations [26]. In addition, children were in a context where all the doubts that could arise could be cleared. These two factors are determinants to encourage societial change.

The workshops were done as a school activity and during school hours, sometimes in the classroom or in the Environmental Room from the city hall. The participation was mandatary as part of the education but not integrated as a subject of the curriculum. Besides, students did not know the objective of the survey, only the workshop monitors knew. The students were asked to respond to the questionnaire individually, without sharing information with their peers.

In order to fulfil the research objectives described above, we proceeded in two phases (see Table A1): firstly, a survey was carried out among students from Ávila and Cádiz before a training workshop about aluminium packaging recycling; secondly, a survey was applied after the workshop. In this way, 806 surveys were answered in April 2015. The objectives of these quantitative phases were as follows:

i. To define the level of knowledge that children have packaging recycling in general; and recycling of aluminium packaging, in particular.
ii. To know the level of awareness that children have about recycling.
iii. To identify the children's intention to recycle in the future.

The choice of Ávila and Cádiz was for two reasons. First, the diversity in location and social context; Cádiz is a coastal population with a high unemployment rate and significant emigration. In contrast, Ávila is a population of the interior, with a more closed culture and with less external influence. Secondly, the ARPAL association has collaborators in the two cities to carry out the workshops in the schools. In Cádiz, the collaborators are University of Cádiz volunteers and trainers from EQUA, a social association that fights for the socio-labour integration of people with intellectual disabilities. In Ávila, the collaborators are two artists who make sculptures and crafts with beverage cans. In both cases, they use the same educational materials, prepared by the association itself.

The two questionnaires assessed identical items, even though the second questionnaire included a question to assess the workshop and reflect on participants' feelings. The survey used open questions (without any structure or association of concepts) and closed questions (multiple choice, dichotomous and scale of importance). The questionnaire was composed of seven questions that might show knowledge, awareness, and intention, as follows:

i. Four questions related to knowledge: on the general use of the selective collection containers (open question), on the recognition of aluminium containers (open) and on the container about where to deposit aluminium packaging for recycling (multiple choice), moreover, there was a question about how they have gotten information about recycling with multiple answers (the concepts "talks" and "school" were included).
ii. Two questions on awareness of the importance of their individual participation in the recycling of aluminium packaging (answer with a scale of 0 to 10, where 0 was highly unimportant and 10 highly important and open answer to explain the reasons) and on the benefits of their individual action of recycling (multiple choice question).
iii. A question about their actual performance regarding recycling (in questionnaire two, Q2, was about their intention to recycle) of different containers and materials with dichotomous response (yes or no).
iv. Finally, in questionnaire two, there was a final question to assess the workshop (multiple choice question).

The questionnaires were held on the following dates: April and May 2015, in schools located in Cádiz and Ávila. In total, 806 students answered the questionnaires: 516 from the 11 schools of Cádiz and 290 from the eight schools of Ávila.

Given the development of the workshop, different activities and materials were developed by the research group. All workshops were divided in two parts:

(a) First, children started the workshop with a theoretical section that was oriented to understanding the aluminium packaging life cycle, different aluminium packaging (rigid, semi-rigid and flexible), how they should be prepared for recycling (in the case of semi-rigid and flexible) and where they should be deposited. Samples of aluminium packaging and a yellow container were also taught. Some support materials (all developed by ARPAL) like videos, games and posters were used. The theoretical section also included an explanation of the benefits of recycling aluminium packaging, a poster about the life cycle of aluminium packaging and viewing two videos (one about aluminium recycling and one about the packaging made of aluminium).

(b) The second part of the workshop was 100% practice, the attendants did some handicrafts with aluminium packaging such as singers, a candelabrum and a whistle. The objective of this practice was assuring a right knowledge of the different aluminium packaging by working with them. Children used empty beverage cans, trays, closures and foil among other aluminium packaging. It was a period in which the students spent time experiencing with aluminium among their peers.

The workshop had an average duration of two hours, one hour for the theoretical section and another for the realisation of handicrafts which each participant took home. The workshops are not included as material of the school curriculum but they are addressed in the classrooms and/ or in the Environmental Room (run by the city hall) and during the school schedule.

ARPAL is very interested in measuring the efficacy of its workshops as well as evaluating the possible efficacy differences between the schools in the two cities. ARPAL's contribution to the paper was working with the authors in developing the protocol and record forms and facilitating that the workshop attendants could record the information pre-and post-workshop. Authors also attended some of the workshops to understand better how ARPAL works and interacts with the workshops monitor.

4. Results

In order to measure the effect of a change in awareness, knowledge, and on the behaviour of children towards the approach of recycling aluminium, several statistical analyses were undertaken. A total of 797 valid surveys were gathered in the "pre" and "post" workshop campaigns, given the awareness towards recycling. The statistical procedures were conducted systematically for both the related samples of the two groups; before and after workshop campaign regarding circular economy and specifically the recycling. The first step was to analyse the differences using the descriptive statistics with the percentage proportions for both pre-post campaigns. The second step was to make a hypothetical mean comparison between the variables for pre-post campaigns. Finally, if there were differences found regarding the two groups (before and after workshop campaigns), the significance test was conducted to determine and assess those differences for both before and after workshop campaign.

4.1. Descriptive Analysis

The first step of the analyses consisted in the mean comparisons for the two samples, i.e., before and after the workshop. Tables A2–A7 show the descriptive statistics of the two samples, where the mean differences in both cases before and after the workshop, for the three variables: knowledge, conscience, and intended behaviour towards recycling are shown. Overall, the results suggest a positive change in awareness and behaviour on the children towards recycling aluminium after the workshop.

The most relevant statistical conclusions regarding the two sites (Cádiz and Ávila schools) are: first, the previous knowledge about containers for recycling was much lower in the Avila centres (18%) than in the Cádiz ones (41%). After the workshop, the knowledge grew in both city centres, the difference being larger in the Cádiz (92%) than in Avila (28%). This could be explained by the previous environmental actions carried out by the Andalusian regional government (Junta de Andalucía) aimed to primary and secondary schools [45]. It can be concluded that those workshops reinforced the previous recycling knowledge.

Second, students from Avila could mention more flexible aluminium packaging before and after the workshops than the kids from Cádiz (24% in Avila arriving to 42%. In Cádiz, the starting point was 10% and after reached 29%). The authors insight about that issue is that ARPAL had successfully organised contests on handicrafts (with Christmas and Halloween designs) made of aluminium packaging for two years; even though these students had not participated, they were aware of them and were familiar with the aluminium works made in their school.

In analysing the knowledge of the whole sample of children on recycling before the campaign, about 70% of them answered that plastic materials go to the yellow container. Only 30% of them answered it correctly by stating that metal, aluminium, and cans must be deposited in the yellow container for recycling. After the campaign, the children who understood the kind of materials to be deposited in the yellow container increased drastically to 69%. Table A2 shows the statistical comparison between the before and after campaign results, where the difference in both pre-post campaigns is shown (from 0.33 to 0.69). Therefore, results suggest that there is a positive change in the knowledge of children regarding the containers and the separation of material with respect to the different containers after the campaign.

The children's knowledge of aluminium packaging specifically also changed positively in the post-campaign results. Before the campaign, 57% of the children had knowledge on aluminium packaging, whereas after the campaign the proportion changed to 93% of them listing correctly the various aluminium packaging which can be grouped into rigid, semi-rigid, and flexible materials (see Table A3).

Before the campaign, 52% of children responded correctly to which container aluminium material could be deposited. After the campaign, the percentage increased drastically to 83%, suggesting the effectiveness of the campaign in bringing awareness to the children of the container in which aluminium materials can be recycled (see Table A4).

Regarding the assessment of children's opinion on the importance of participating in recycling (Table A5), although weak, showed a positive change (1% increment). However, the sharp increase of standard deviation may be due to the fact that, the spread of responses (between 6 and 10 being important and highly important) was very low surrounding a 90% of responses between 6 to 8 score (SD = 2.072) before the workshop, compared to after workshop with a large spread on the scale between 6 to 10 (SD = 4.105).

Likewise, the children's response on their consciousness of benefits received on recycling, although a positive change, was found to be weak (3% increment). This may be due to the partial loss of data, as many responses of children who considered that recycling is beneficial to "us" (the people, city and planet) highlighted the importance with an open answer like, "for our oxygen", but failed to choose the multiple choices (Table A6).

However, (Table A7) the responses on children's intention of behaviour towards recycling changed after the campaign. Their responses ranged from 51 to a 60% before the campaign on their positive intention of behaviour towards recycling certain aluminium materials like cans, bricks, aluminium packs, aluminium foil and other metallic materials compared to a range of 55 to 62% after the campaign, except for their response on bricks with a 1% decrease in the positive change.

Overall, the results from the descriptive statistical analyses suggest that there is existence of statistical differences in the children's responses before and after the campaign on recycling. Therefore, consequently, we conducted the statistical analyses to confirm if these differences were statistically significant enough to hypothetically conclude the changes before and after the campaign. We perform the analyses of significance test statistics subsequently.

4.2. Test Statistics

Since we know that the proportion of children's' knowledge, conscience and positive behaviour towards recycling has increased following the workshop campaigns, a statistical test was performed to confirm the significance of these differences. Since some of the dependent variables regarding recycling were measured on a dichotomous scale for the two related groups; before and after the workshop campaigns, the McNemar's test was performed (Table A8) and for the rest of the continuous variables, the Wilcoxon signed rank test was conducted (Table A9).

The results from the test statistics (Tables A8 and A9) show that the changes on each of the variables; knowledge on recycling of aluminium material (separation of material to yellow container, knowledge on different aluminium materials, knowledge on containers for recycling), the importance of recycling, and finally on the positive intention of behaviour on recycling (except for bricks material, $p > 0.05$), before and after the campaign show statistically significant differences ($p < 0.05$). Therefore, we can conclude that the differences between pre-post campaign responses among the children are statistically significant on each of the variables; knowledge, conscience, and intention of behaviour towards recycling, which suggests the effectiveness of the campaign among young children towards recycling.

5. Discussion and Conclusions

Firstly, this paper covered the main objective by measuring the effectiveness of workshops related to circular economy concepts and based on three parameters: knowledge imparted on aluminium packaging and recycling, awareness of recycling and intention to recycle after attending a workshop. To the best of our knowledge, these three specific aspects have not been assessed before in this kind of activity. Moreover, this research can be used by teachers and other researchers to develop their own activities to rise the environmental awareness among children.

The statistical significance proves that the awareness on recycling can be learnt by young people onwards (aged from 8 to 12 in this study) and environmental education may provide effective information towards a social change and a sustainable behaviour. Then, taken together, the results of the statistical analysis suggest that the workshops on aluminium packaging recycling have served to increase knowledge, awareness, and intention of recycling aluminium packages among the public studied from the schools of Ávila and Cádiz. Before the present investigation, 70% of the respondents thought so and after the workshop, 69% knew the correct use of the yellow container. Then, regarding the acquired knowledge after the workshop, participants are better aware of the use of the yellow container and the materials to be disposed of there. Besides, workshops have also served to increase awareness of packages made of aluminium (and therefore can and should be recycled) and where to deposit them (in the yellow container). Concerning this last aspect, it is worth highlighting an increase of 20 points in the percentage of correct answers in the second questionnaire.

Another important contribution of the findings from current research to bring awareness towards recycling to future generations is that it may lead to achieve the circular economy objectives in the European countries. The campaigns improve the understanding of participation in recycling in the society, and how it can lead to the benefits of the people, society and world overall. Furthermore, the results suggest that campaigns are effective in promoting the positive intentions of behaviours in children towards recycling. In other words, this study shows that as the knowledge, importance and conscientiousness on recycling are increased among children, the children's intention to recycle in the future increases too. However, due to practical constraints, this paper cannot provide a comprehensive review of the final recycle action.

In conclusion, this research confirmed that the workshops are a powerful tool to teach environmental knowledge and changing habits in favour of recycling. Moreover, it would be interesting to examine the relevance of the environment for the workshops which promote friendly environmental actions and define if they are more effective in a familiar environment such as the school with participants' classmates, but also in a much more playful, fun and out of class routine. Thus, from this study, it could be concluded that sustainability issues need to be effectively communicated to stakeholders.

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Author Contributions: This paper is the result of teamwork. Pilar Buil and Olga Roger-Loppacher conceived and designed the research. Rejina M. Selvam analyzed the data. Pilar Buil, Olga Roger-Loppacher and Vanessa Prieto-Sandoval discussed the results. Pilar Buil, Olga Roger-Loppacher and Vanessa Prieto-Sandoval wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Time, techniques and sources.

Fieldwork Phases			
Phase	**Time**	**Research Technique**	**Research Sources**
I hase: quantitative research	Before the workshop	First questionnaire (Q1)	797 students (281 students from Ávila & 516 students from Cádiz)
II Phase: quantitative research	After the workshop	Second questionnaire (Q2)	797 students (281 students from Ávila & 516 students from Cádiz)

Table A2. Knowledge on yellow container.

Container Knowledge	*N*	Mean	Standard Deviation
Before	797	0.33	0.47
After	794	0.69	0.46

Table A3. Knowledge on aluminium packaging.

Aluminium Material Knowledge	*N*	Mean	Standard Deviation
Before			
Rigid	797	0.33	0.47
Semi Rigid	797	0.05	0.21
Flexible	797	0.19	0.39
After			
Rigid	793	0.45	0.49
Semi Rigid	793	0.12	0.32
Flexible	793	0.36	0.48

Table A4. Knowledge on container deposit of aluminium packaging for recycling.

Container Knowledge of Aluminium	*N*	Mean	Standard Deviation
Before	796	0.52	0.50
After	793	0.83	0.71

Table A5. On the importance of recycling aluminium packaging.

Opinion on Importance of Recycling	*N*	Mean	Standard Deviation
Before			
Important	790	8.77	2.072
After			
Important	786	9.17	4.105

Table A6. Awareness of benefits of recycling aluminium packaging.

Recycling Benefits for "Us"	*N*	Mean	Standard Deviation
Before	796	0.39	0.48
After	792	0.42	0.50

Table A7. Intention of behaviour towards recycling.

Positive Behaviour towards Recycling Materials	*N*	Mean	Standard Deviation
Before			
Beverage cans	788	0.53	0.49
Bricks	788	0.60	0.49
Aluminium packs	792	0.54	0.49
Aluminium foil	797	0.51	0.50
Other metallic	791	0.52	0.50
After			
Beverage cans	784	0.62	0.48
Bricks	783	0.61	0.48
Aluminium packs	782	0.62	0.61
Aluminium foil	785	0.57	0.49
Other metallic	797	0.55	0.49

Table A8. Test statistics (McNemar).

Before & After	*N*	Chi-Squared	Exact Sig (*p*-Value)
Knowledge on yellow container	794	237.92	0
Knowledge on Aluminium Material			
Rigid	793	38.03	0
Semi-rigid	793	40.72	0
Flexible	793	81.36	0
Positive Intention of Behaviour on Recycling			
Beverage cans	778	18.85	0
Bricks	775	0.62	0.42
Aluminium packs	778	13.5	0
Aluminium foil	785	13.48	0
Other metallic	791	3.65	0

Table A9. Test statistics (Wilcoxon signed Rank test).

Before & After	Z	*p*-Value (Bilateral)
Container Knowledge of aluminium	−12.45	0.000
Opinion on Importance of recycling	−6.70	0.000
Recycling Benefits for "Us"	−1.63	0.001

References

1. UNEP. *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth*; International Resource Panel Lead, Ed.; UNEP: Nairobi, Kenya, 2011; ISBN 9789280731675.
2. Stahel, W.R. The Circular Economy. *Nature* **2016**, *531*, 435–438. [CrossRef] [PubMed]
3. Prieto-Sandoval, V.; Jaca García, C.; Ormazabal Goenaga, M. Circular Economy: An economic and industrial model to achieve the sustainability of society. In *Rethinking Sustainability Models and Practices: Challenges for the New and Old World Contexts, Proceedings of the 22nd Annual International Sustainable Development Research Society Conference, Lisbon, Portugal, 13–15 July 2016*; Joanaz de Melo, J., Disterheft, A., Caeiro, S., Santos, R.F., Ramos, T.B., Eds.; ISDRS: Lisbon, Portugal, 2016; Volume 2, pp. 504–520, ISBN 978-972-674-791-8.
4. Wu, H.; Liu, Y.; Xia, Q.; Zhu, W. Measuring Efficiency of Recycling Systems Based on Data Envelopment Analysis (Dea) Network: A case from Chinese provincial circular economy. *Environ. Eng. Manag. J.* **2014**, *13*, 1089–1099.
5. Haas, W.; Krausmann, F.; Wiedenhofer, D.; Heinz, M. How Circular Is the Global Economy: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *J. Ind. Ecol.* **2015**, *19*, 765–777. [CrossRef]
6. Yuan, Z.; Jiang, W.; Liu, B.; Bi, J. Where Will China Go? A Viewpoint Based on an Analysis of the Challenges of Resource Supply and Pollution. *Environ. Prog.* **2008**, *27*, 503–514. [CrossRef]
7. Yong, R. The circular economy in China. *J. Mater. Cycles Waste Manag.* **2007**, *9*, 121–129. [CrossRef]
8. Moreno, M.; De los Rios, C.; Rowe, Z.; Charnley, F. A conceptual framework for circular design. *Sustainability* **2016**, *8*, 937. [CrossRef]
9. Eurostat. *Each Person in the EU Generated 481 kg of Municipal Waste in 2013*; Eurostat: Luxembourg, 2015; pp. 54–56.
10. Yau, Y. Stakeholder engagement in waste recycling in a high-rise setting. *Sustain. Dev.* **2012**, *20*, 115–127. [CrossRef]
11. Kronrod, A.; Grinstein, A.; Wathieu, L. Go Green! Should Environmental Messages Be So Assertive? *J. Market.* **2012**, *76*, 95–102. [CrossRef]
12. Howes, M.; Wortley, L.; Potts, R.; Dedekorkut-Howes, A.; Serrao-Neumann, S.; Davidson, J.; Smith, T.; Nunn, P. Environmental Sustainability: A Case of Policy Implementation Failure? *Sustainability* **2017**, *9*, 165. [CrossRef]
13. Chang, Y.-J.; Schneider, L.; Finkbeiner, M. Assessing Child Development: A Critical Review and the Sustainable Child Development Index (SCDI). *Sustainability* **2015**, *7*, 4973–4996. [CrossRef]
14. Martin, N.T.; Ross, S.R.; Irwin, R.L. Utilizing community-based social marketing in a recycling intervention with tailgaters. *J. Intercoll. Sport* **2015**, *8*, 57–81. [CrossRef]
15. Loubser, C.; Noor Azlin, Y.; Dreyer, J.; Nik Azyyati, A.K. The effectiveness of environmental education workshops for teachers, learners and schools in Malaysia. *Environ. Dev. Sustain.* **2014**, *16*, 1163–1176. [CrossRef]
16. Rickinson, M. Learners and Learning in Environmental Education: A critical review of the evidence. *Environ. Educ.* **2001**, *7*, 207–317. [CrossRef]
17. Svetina, M.; Istenic-Starcic, A.; Juvancic, M.; Novljan, T.; Subic-Kovac, M.; Verovsek, S.; Zupancic, T. How children come to understand sustainable development: A contribution to educational agenda. *Sustain. Dev.* **2013**, *21*, 260–269. [CrossRef]
18. European Aluminium. *Recycling Aluminium: A Pathway to a Sustainable Economy*; European Aluminium Association: Brussels, Belgium, 2015.
19. Buil, P.; Roger-loppacher, O.; Marimon, F. El impacto de los SMS entro los adolescentes en campañas de reciclaje [The impact of SMS messages on young people's participation in recycling campaigns]. *Comun. Soc.* **2014**, *27*, 161–182.
20. Bailey, I. Principles, policies and practice: Evaluating the environmental sustainability of Britain's packaging regulations. *Sustain. Dev.* **2000**, *8*, 51–64. [CrossRef]
21. WCED. *Report of the World Commission on Environment and Development: Our Common Future Acronyms and Note on Terminology Chairman's Foreword*; Oxford University Press: Oxford, UK; New York, NY, USA, 1987.
22. Mebratu, D. Sustainability and sustainable development. *Environ. Impact Assess. Rev.* **1998**, *18*, 493–520. [CrossRef]

23. Lozano, R. Envisioning sustainability three-dimensionally. *J. Clean. Prod.* **2008**, *16*, 1838–1846. [CrossRef]
24. UN. *Transforming Our World: The 2030 Agenda for Sustainable Development*; UN: New York, NY, USA, 2015; Volume 16301.
25. Boulding, B.K.E. The Economics of the Coming Spaceship Earth. In *Environmental Quality In a Growing Economy*; Johns Hopkins Press: Baltimore, MD, USA, 1966; pp. 1–8. [CrossRef]
26. Van Buren, N.; Demmers, M.; van der Heijden, R.; Witlox, F. Towards a circular economy: The role of Dutch logistics industries and governments. *Sustainability* **2016**, *8*, 647. [CrossRef]
27. Ying, F.; Wen-Ping, Z. Circular economy development phase research based on the IPAT equation: The case of Shaanxi. *Ekon. Horizonti* **2015**, *17*, 33–44. [CrossRef]
28. Ellen MacArthur Foundation. *Towards The Circular Economy*; Ellen MacArthur Foundation: Courts, UK, 2013; Volume 2.
29. McDonough, W.; Braungart, M. *Cradle to Cradle: Remaking the Way We Make Things*; North Point Press: New York, NY, USA, 2002; ISBN 9780865475878.
30. European Commission. *Closing the Loop—An EU Action Plan for the Circular Economy*; European Commission: Brussels, Belgium, 2015.
31. European Commission. *European Resource Efficiency Platform Working Group I Circular Economy/Greening the Economy First Report to Sherpas*; European Commission: Brussels, Belgium, 2012.
32. Murga-Menoyo, M.Á. Educating for local development and global sustainability: An overview in Spain. *Sustainability* **2009**, *1*, 479–493. [CrossRef]
33. IB. Circular Economy Now Included in IB Curriculum. Available online: http://www.ibo.org/news/news-about-the-ib/circular-economy-now-included-in-ib-curriculum/ (accessed on 25 January 2017).
34. Roger, O. Revista Recupera. Available online: http://gremirecuperacio.org (accessed on 14 December 2017).
35. Olander, F.; Thogersen, J. Understanding of Consumer Behaviour as a Prerequisite for Environmental Protection. *J. Consum. Policy* **1995**, *18*, 345–385. [CrossRef]
36. Nadlifatin, R.; Lin, S.C.; Rachmaniati, Y.P.; Persada, S.F.; Razif, M. A pro-environmental reasoned action model for measuring citizens' intentions regarding ecolabel product usage. *Sustainability* **2016**, *8*, 1165. [CrossRef]
37. Asharose; Saizen, I.; Sasi, P.K.C. Awareness Workshop as an Effective Tool and Approach for Education in Disaster Risk Reduction: A Case Study from Tamil Nadu, India. *Sustainability* **2015**, *7*, 8965–8984. [CrossRef]
38. Arpal. *Informe Recuperación de Envases de Aluminio-2015*; Arpal: Madrid, Spain, 2016.
39. Arpal. *Informe Recuperación de Envases de Aluminio-2016*; Arpal: Madrid, Spain, 2017.
40. Ecoembes. *Integrated Annual Report*; Ecoembes: Madrid, Spain, 2015.
41. Ecoembes. *Recycling Results 2016 [Resultados Reciclaje 2016]*; Ecoembes: Madrid, Spain, 2016; Available online: https://www.ecoembes.com/sites/default/files/reciclaje-en-datos-2016.pdf (accessed on 14 December 2017).
42. Cheung, Y.T.-Y.; Chow, C.-F.; So, W.W.-M. A train-the-trainer design for green ambassadors in an environmental education programme on plastic waste recycling. *Int. Res. Geogr. Environ. Educ.* **2017**, 1–19. [CrossRef]
43. Buil Gazol, P.; Roger-Loppacher, O. Medio ambiente y relaciones públicas: Planificación estratégica de campañas de comunicación ambiental en España [Environment and public relations: Strategic planning in environmental communication campaigns in Spain]. *Rev. Mediterr. Comun.* **2015**, *6*, 45–58. [CrossRef]
44. Mckenzie-Mohr, D. Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing. *J. Soc. Issues* **2000**, *56*, 543–554. [CrossRef]
45. De Andalucía, J. ALDEA-Educación Ambiental para la Comunidad Educativa. Available online: http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.220de8226575045b25f09a105510e1ca/?vgnextoid=dabed756d6359310VgnVCM1000001325e50aRCRD&vgnextchannel=f34be156217d4310VgnVCM2000000624e50aRCRD (accessed on 27 November 2017).