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Investigating UK School-Aged Children's Sustainable Food Packaging Disposal Knowledge and Engagement Levels in Ecologically Valid Settings

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Abstract: There is a growing emphasis on sustainable approaches; however, consumer-related barriers can modulate adherence. Therefore, engaging future generations from an early age in adopting sustainable food-packaging practices is fundamental. This paper investigates food-packaging-related knowledge, preferences, and engagement levels at a UK science-based event. School-aged children (n = 255; 8–18 years) completed various activities to initiate conversation encompassing food packaging disposal, symbols, issues, preferences, and behaviour, as well as educational-based discussions. Most children were able to select the correct response for disposal-related questions; however, they struggled to correctly identify the appropriate bin for used food items (e.g., pizza box). Children's knowledge of symbols varied considerably: Mobius loop and Fairtrade symbols were easily recognisable, whereas there was no clear consensus/poor knowledge for the remaining symbols. Children's main food packaging issues were 'excessive packaging' and 'bins are full' and key information searching locations were labels-on-pack and digital sources. Currently, 51% of the children adopt sustainable approaches; therefore, engaging more children in such practices is essential. 77% of the children were interested in changing future food-packaging behaviour. Going forward, sustainable food-packaging practices need to be incorporated into the school curriculum to promote engagement as well as improving infrastructure so that children can easily implement appropriate practices; thus, resulting in notable societal impact.

Keywords: sustainability; food packaging; children; engagement; education

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1. Introduction

Sustainability can be described as meeting current needs without impacting future generations and encompasses three key elements: environmental, social, and economic [1,2]. More specifically, the food system has an active role in helping to reduce its environmental impact as well as influencing consumers' sustainable behaviour [3]. Currently, it is evident that sustainability is in the foremind of consumers' minds; yet, in most cases, consumers struggle to easily implement such practices [4,5]. Common consumer-related sustainable food practices include: reuse, reduce, recycle, composting, appropriate disposal (e.g., sorting waste into different bins), plant-based diets, consuming local foods and labelled food products (e.g., organic, ethical) [6–8]. In addition, consumers cited cost, limited local facilities, inconsistency in recycling rules, food packaging composition, ignorance of societal benefit, labelling-related confusion, and time as key barriers to adopting sustainable food-packaging behaviours [3–5,9]. This is especially relevant since food packaging relies on correct consumer interpretation relating to disposal of packaging material (such as glass, metal, paper, cardboard, and plastic) appropriately, resulting in notable societal challenges [1,9–13]. Hence, there is increasing emphasis on improving accessibility and infrastructure to modulate consumer behaviour at a population level [4,5,14].

Food packaging is associated with multiple key functions, such as protection, information, traceability, and convenience, as well as influencing consumers' attention, expectations, and food choice [15–18]. More specifically, labels-on-pack can highlight key characteristics and elicit positive associations as well as nudge consumers to make more sustainable food choices [13,19–22]. However, there is widespread confusion as well as an associated mismatch in knowledge relating to sustainable food packaging symbols and appropriate food-packaging disposal [3,9,11,23–26]. In addition, consumers often lack understanding as to how individual actions in their everyday lives contribute to the wider picture (such as climate change) [3]. Accordingly, it is important to check current awareness and correct interpretation so that future strategies can be developed as well as ensure transparency in terms of food products environmental impact [27].

It is fundamental to engage school-aged children from an early age in sustainability-based concepts and its subsequent global implications in order to maximise impact [28–31]. Moreover, children have a key role in influencing a household's behaviour as well as being 'agents of sustainable change' and utilising 'pester power' which indicates the importance of conducting research within this age group [29,31–33]. In addition, children need sufficient awareness of sustainable food packaging-related symbols and different packaging materials as well as subsequent disposal-related knowledge so they can successfully implement sustainable behaviour [1,30,34]. Positively, a recent meta-analysis noted that environmental education can improve children's knowledge, attitudes, intentions, and self-reported behaviour; however, areas for future research relate to diversifying methodological approaches so as to maximise impact [31]. Thus, to improve compliance and adherence to sustainable food packaging, emphasis should be placed on targeted education involving the next generation.

Currently, there is a growing prominence on developing suitable educational activities to help facilitate sustainable food packaging-related actions for school-aged children. For example, Castellano et al. [30] used a social robot, 'PepperRecycle' to help encourage appropriate waste disposal in Italian children aged 7–9 years. Workshops have also been utilised during school hours as a classroom-based activity; Buil et al. [35] positively influenced aluminium-based recycling knowledge, awareness, and intention in Spanish children aged 8–12 years. Our previous work also conducted successful interactive food-packaging workshops (via worksheets, activity booklets, discussions, presentations, and competitions) in Reading (Berkshire, UK) primary and secondary schools with children aged 7–14 years [36,37]. In addition, education enhanced the food packaging symbol- (tidyman and green dot) and disposal- (juice bottle, baked bean can, jelly pot, ketchup bottle and pizza box) related knowledge [36]. Moreover, children need to implement effectively learning in different locations (such as home and school); accordingly, children were provided with an activity booklet and ten food items to be completed at-home for one week to track appropriate food-packaging disposal [36,38]. In addition, previous research has cited mixed materials (plastic + cardboard/paper), metal, glass, cleaning prior to disposal, and confusion in terms of what can or cannot be recycled as key barriers in school-aged children [36,38,39]. It is also important to understand how research supports various Sustainable Development Goals (SDG) to maximise impact [40]. For example, this research contributes to (1) Goal 4: quality education (e.g., encouraging engagement in sustainable education from childhood); (2) Goal 9: industry, innovation, and infrastructure (e.g., identifying current infrastructure-related challenges in terms of council-based recycling); (3) Goal 12: responsible consumption and production (e.g., children need to be able to appropriately dispose of food packaging); (4) Goal 13: climate action (e.g., children need to be aware of climate change and its subsequent consequences for future generations); and (5) Goal 14: life below water (e.g., reducing plastic waste via citizen science) [40]. This suggests engaging school-age children in appropriate disposal practices (from reviewing symbols to understanding material types) could be a vital first step in encouraging a shift towards more sustainable practices as well as having widespread societal impact. However, it is imperative that research addresses key limitations: (1) encompassing more sustain-

able aspects to fully understand current challenges; (2) capturing broader age groups and geographic spread; and (3) using more real-life settings (e.g., beyond the classroom). Therefore, it is fundamental to utilise interactive activities (an important learning approach to promote children's involvement with materials by encouraging children to think, listen, ask questions, and apply knowledge (theory to practice) [41]) in ecologically valid settings (at public events where children are less aware research is being conducted and considered pressure-free since outside the classroom) so that engagement and knowledge can be effectively captured. Such an approach warrants relevant investigation so that tailored school-aged materials can be developed in the future. Moreover, the implications of this research could help encourage interest and initiate conversation in school-aged children relating to sustainable food packaging. Accordingly, this paper investigates food packaging-related knowledge, issues, preferences, and engagement levels at a UK science-based event via the following research questions: (1) do children adhere to appropriate food-packaging disposal?; (2) what are children's awareness and knowledge relating to common food packaging and sustainable food-related symbols?; and (3) what are children's current food-packaging engagement levels, common issues, and preferences?

2. Materials and Methods

2.1. Activity Overview

Children (n = 255; 8–18 years; 33% male, 66% female, and 1.2% other) from different schools across the UK attended a science-based event in London (UK) during school hours. Utilising the Yamane's formula ($n = \frac{N}{1+Ne^2}$ where n = sample size; N = population; and e = precision) it was apparent that approximately 100 children would be appropriate to take part based on a 10.7 million population size and 0.1 precision factor [42,43]. In addition, school-aged children are considered to engage positively with interactive activities as well as have adequate literacy skills to complete such tasks [36,37,44]. The activities were designed for children (across the different key stages (KS2: 7–11 years; KS3: 11–14 years; KS4: 14–16 years; and KS5: 16–18 years)—increasing age-specific national curriculum requirements) with the aim of promoting learning, education, and initiating conversation relating to sustainable food packaging focusing on five key components (Figure 1). More specifically, children visited the stand and were asked if they wanted to take part in a series of interactive activities on food packaging (children could withdraw from the activities at any time without giving a reason). All schools consented to participate in the activities when signing up to the event, and the activities were designed to be as inclusive as possible; hence, a minimal exclusion criterion (such as aged 18 years and over) was used. The activities had a favourable opinion for conduct from the University of Reading—School of Chemistry, Food, and Pharmacy ethics committee (study number: 04/2023). Children completed the activities independently either using paper/pen or digitally on iPads (Apple, London, UK).

Figure 1. Summary of the activity's five key components.

2.2. Food-Packaging Disposal

This activity focused on understanding children's appropriate disposal-related knowledge, awareness, and implementation. Children had to select the most appropriate bin (general waste, recycling, food waste, or bottle bank; multiple choice-based question) for the disposal of three food items: (i) tomato soup can (clean); (ii) mayonnaise bottle (used); and (iii) pizza box (used), representing metal, plastic, and cardboard-based materials (Figure 2).

The rationale for selection was based on key findings from our previous work and aimed to avoid food items with potential regional disposal differences [6,36]. In addition, children were asked three questions: (1) are local recycling systems the same across the UK?; (2) do you need to clean food packaging prior to disposal?; and (3) do you need to separate food packaging prior to disposal? via a single-selection response question (YES or NO) to capture children's broader knowledge and awareness.

Figure 2. Overview of the activity-related icons for food items, symbols, and issues/preferences.

2.3. Food-Packaging Symbols

It is important that children are able to recognise and correctly interpret various sustainable food packaging-related symbols. Accordingly, this activity followed a two-fold approach, where children were asked to: (1) determine the appropriate meaning for the 'Tidyman', 'Green Dot' and 'Mobius Loop' symbols via a multiple choice-based question, and (2) identify if they had seen the 'Fairtrade', 'Rainforest Alliance' and 'Foundation Earth Eco-labels' before in order to understand whether children could recognise sustainable food-based symbols. In addition, as a follow-up question, children confirmed if they could understand the symbols' meaning via a single-selection response question (YES or NO). It should be noted that if children selected 'YES' they were asked to write the meaning in a comment box to check correct interpretation. The six symbols were selected as they are considered common food-packaging symbols in the UK (Figure 2).

2.4. Food-Packaging Issues and Preferences

This activity aimed to capture children's current approaches, issues, and preferences to help future engagement. Children were asked whether they adopted any sustainable approaches (e.g., reuse, recycle, reduce, etc.) via a single-selection response question (YES or NO) to understand the proportion of children currently following such practices and to identify areas for improvement. If children selected 'YES' they were asked to provide some examples of their sustainable approaches. Additionally, children were asked if they have any food-packaging issues and their common searching locations for information via a check-all-that-apply (CATA) icon-based question (Figure 2). It was important to prevent fatigue and to avoid having too many responses; accordingly, selected key responses were based on our previous work and used icons to ensure suitability [36].

2.5. Future Behaviour

This activity reviewed future behaviour and basic demographics. Accordingly, children were asked if they were interested in modulating future food-packaging disposal behaviour via a single-response question (YES or NO). Children were also asked to jot down what would encourage them to adopt more sustainable food-packaging practices

via an open-ended question to enable a more unstructured means of providing feedback. Finally, children were asked to confirm their age, county of residence, and gender.

2.6. Education

The final aspect of the activity focused on learning and education via informal one-to-one or small-groups- (two to six children) based discussions. For example, once children had completed the disposal, symbols, issues/preferences, and future behaviour aspects, they were encouraged to think, listen, ask questions, and apply knowledge as well as being given the opportunity to review the answers utilising an interactive approach to initiate conversation. In addition, children were shown relevant educational materials with the correct answers to help improve knowledge and awareness.

2.7. Statistical Analysis

The data analysis was completed in XLSTAT (version 2022.3.2.1348, New York, NY, USA) utilising the following approaches: (i) binomial distribution to identify differences between variables (e.g., YES vs. NO, correct vs. incorrect) [36] and (ii) Cochran's Q test for CATA based data with multiple comparisons via the McNemar (Bonferroni) procedure [45]. The value for significance level was $p < 0.05$ for all analyses. Data from the open-ended questions (e.g., current sustainable approaches and encourage future sustainable practices) were compiled with the frequency counts within a recurring theme being recorded [16,46].

3. Results

3.1. Demographics

Two hundred and fifty-five children (12.9 ± 1.8 years) completed the activities predominately from KS3 (64%); however, all key stages were represented (KS2: 20.4%; KS4: 14.5%; and KS5: 1.2%). The cohort were mainly living in London (76%) but also spread across the UK (Surrey: 12.2%; Hampshire: 3.1%; Kent: 2.7%; Hertfordshire: 2.0%; Cambridgeshire: 1.2%; Essex: 1.2%; Liverpool: 0.4%; Bedfordshire: 0.4%; and Perthshire: 0.4%).

3.2. Food Packaging Disposal

Children were able to identify the appropriate disposal bin for the tomato soup can significantly correctly ($p < 0.0001$; Figure 3). However, the opposite effect was apparent for the used food items, where more children answered incorrectly for the mayonnaise bottle and pizza box than correctly ($p < 0.0001$; Figure 3). In addition, there was a significant effect ($p < 0.0001$) for the three disposal questions, where more children were able to select the correct response for differences in UK recycling systems and cleaning/separating food packaging prior to disposal (Figure 3).

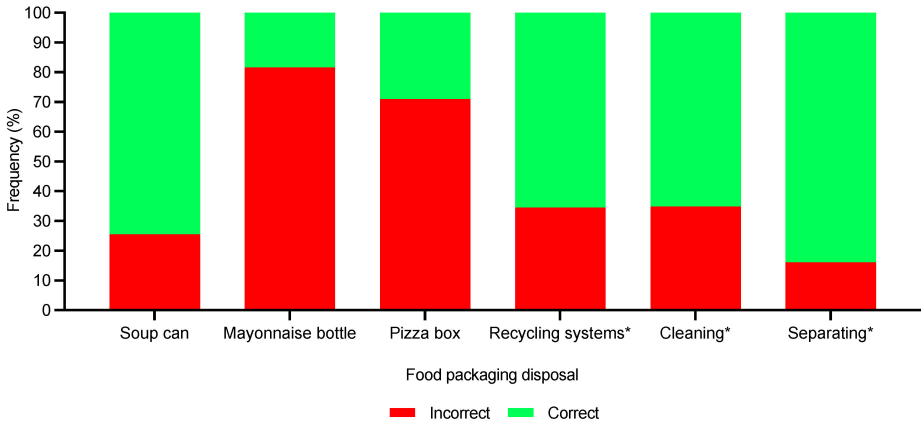

Figure 3. Children's (n = 255) food packaging disposal knowledge (data reported as percentages; * recycling systems (differences in UK recycling systems) and cleaning/separating food packaging prior to disposal).

3.3. Food Packaging Symbols

Positively, 68% of children identified the correct meaning for the Mobius loop symbol ($p < 0.0001$). In addition, there was a similar trend for the Tidyman symbol, where 55% of children selected the correct meaning ($p = 0.052$). However, nearly all children (93%) reported incorrect responses for the Green dot symbol ($p < 0.0001$). It was apparent children were able to recognise the Fairtrade symbol whereas in contrast this was not the case for the Foundation Earth Eco-labels; however, there was no clear consensus for the Rainforest Alliance symbol (Table 1). In terms of interpreting the symbol meaning, most children were unable to do this correctly (Table 1). In addition, overall activity performance was monitored (combining disposal and symbol responses), resulting in 57% of children scoring seven or more correct answers from the fifteen questions (Figure 4).

Table 1. Children's (n = 255) ability to recognise and interpret food packaging symbols.

Symbol	Recognise Symbol [1]		*p*-Value *	Meaning Symbol [2]		*p*-Value *
	Yes	No		Correct	Incorrect	
Fairtrade	79.6	20.4	**<0.0001**	32.2	67.8	**<0.0001**
Rainforest Alliance	51.0	49.0	0.40	6.7	93.3	**<0.0001**
Foundation Earth Eco-labels	34.1	65.9	**<0.0001**	12.5	87.5	**<0.0001**

[1] Have you seen this symbol before? [2] Do you know what this symbol means? * *p*-values reflect two-alternative forced choice test and data reported as percentages.

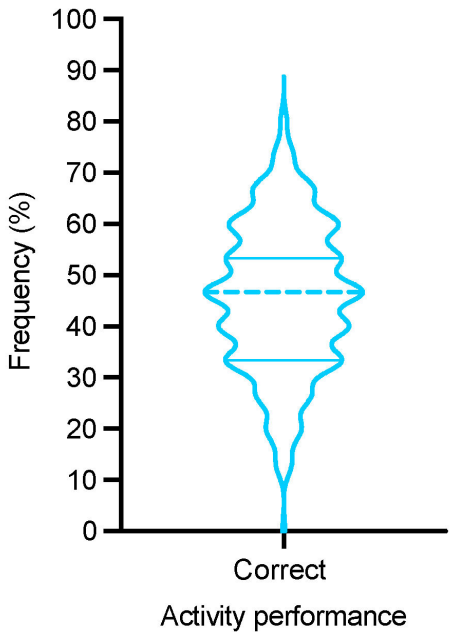

Figure 4. Frequency distribution of activity performance from fifteen questions covering six disposal and nine symbol questions (data reported as percentages; dotted line: median and solid line: lower and upper quartile).

3.4. Food Packaging Issues and Preferences

Children's key food-packaging issues related to excessive packaging and full bins ($p < 0.0001$; Figure 5). In addition, children were asked where they commonly search for food-packaging information, with main sources being labels on packaging, search engines, and mobile apps ($p < 0.0001$; Figure 5). It was evident that there was a mixed response in terms of currently adopting sustainable approaches (yes: 51% vs. no: 49%); moreover, the most common sustainable practice currently adopted relates to recycling (Figure 6).

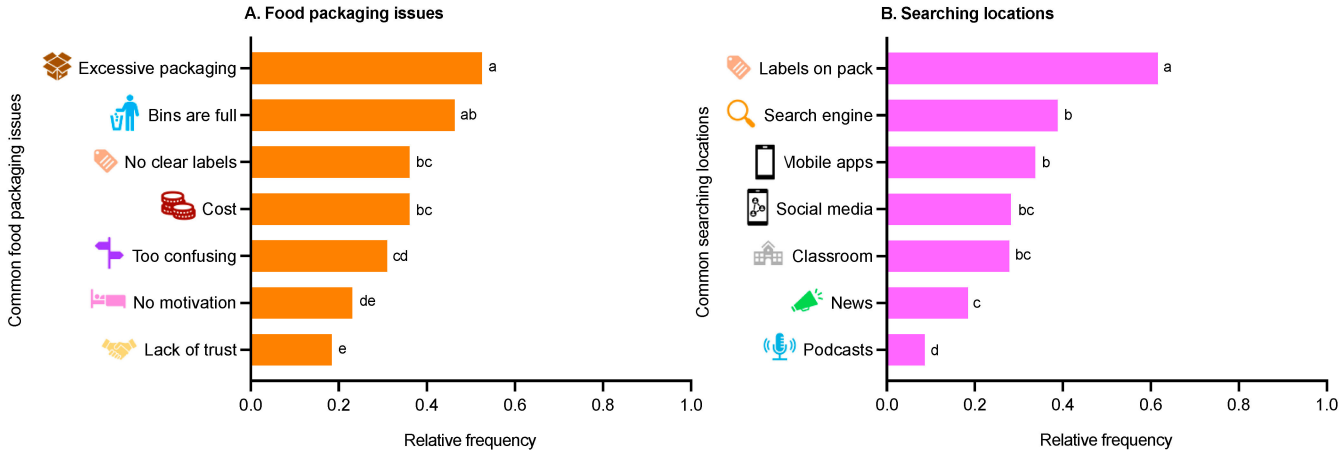

Figure 5. Children's (n = 255) food packaging (**A**) issues and (**B**) searching locations (data expressed as relative frequency, and differing letters reflect significance from multiple comparisons).

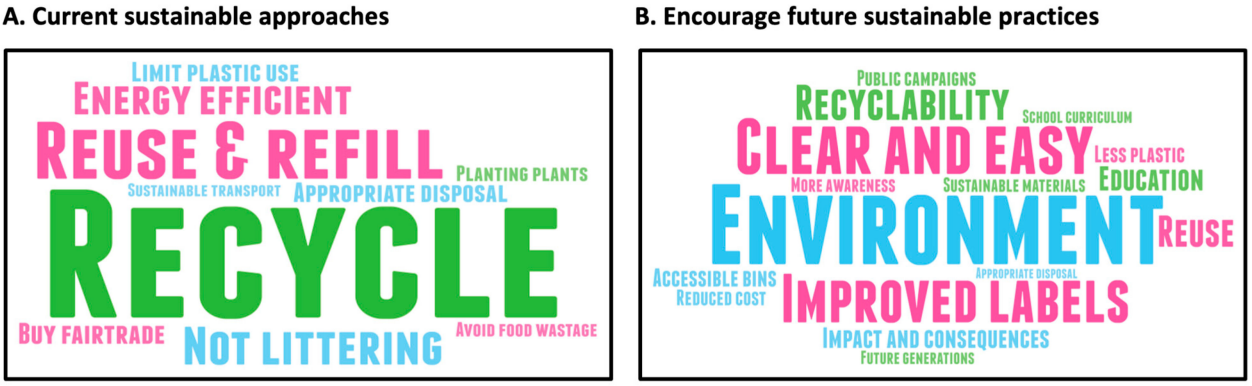

Figure 6. Children's (n = 255) key themes from open-ended questions relating to (**A**) current sustainable approaches, and (**B**) encourage future sustainable practices.

3.5. Future Behaviour

At least 77% of children said they are interested in modulating their future food-packaging disposal behaviour. More specifically, children noted that environment, improved labels, clear/easy, and recyclability would encourage future sustainable practices (Figure 6).

4. Discussion

4.1. Food Packaging Disposal

Children need sufficient knowledge and awareness to correctly implement appropriate disposal practices; accordingly, it is important to capture both dimensions. It was evident that at least 65% of children were able to select the correct response for differences in UK recycling systems as well as the need to clean and separate food packaging prior to disposal. These findings are positive and support to some extent that children have some general knowledge of the topic, most likely from engaging in household practices. However, despite this initial knowledge, children struggled to identify the correct bin for non-clean food packages. For example, more than 70% of the children identified the incorrect response for the dirty mayonnaise bottle and pizza box, whereas the opposite trend was present for clean food packaging (e.g., tomato soup can; ¾ of children noted the correct response). Moreover, it is likely that key contributing factors could relate to the widespread geographical variation and lack of standardisation in kerbside collections (e.g., approximately 39 different bin regimes across the UK), leading to confusion and poor practices in some cases [6,14]. Previously, it has been noted that cleaning and separating food

packaging prior to disposal are areas that would benefit from more clarification [9,36,37]. Such findings were evident in our work and implies that a more targeted approach is needed with guidance for different scenarios (e.g., clean vs. dirty) depending on the material type to improve end-user engagement. Recently, Holmes et al. [14] noted the beneficial societal impact of simplifying the recycling process for both the individual and industry. Therefore, more emphasis should be placed on practical applications to support initial knowledge so that children can implement successfully appropriate disposal practices in their everyday lives.

4.2. Food Packaging Symbols

It is important that children can recognise and understand common food-packaging and sustainable food-related symbols so they can make informed decisions. Moreover, labels-on-pack can provide fundamental product information and help encourage more sustainable food choices [13,19–22]. Overall, it was apparent children struggled, in most cases, to correctly identify the appropriate meaning for various symbols. For example, the majority of children selected incorrectly for the Green dot symbol; however, more than half of the children correctly interpreted the Mobius loop and Tidyman symbol. Such findings support the literature highlighting that more work needs to be done to overcome the associated knowledge gap; positively, classroom-based education can successfully improve food packaging-related symbol knowledge [9,36,37]. However, previous research did not evaluate sustainable food-based symbols (e.g., Fairtrade, Foundation Earth Eco-labels, and Rainforest Alliance) with children; accordingly, they were evaluated in our current paper. It was apparent that children were most familiar with the Fairtrade symbols; this could be expected as this symbol is widely recognised and commonly found on a range of products (such as bananas, cocoa, coffee, flowers, sugar, tea, etc.) [47]. Surprisingly, despite the Rainforest Alliance being present on a plethora of products (e.g., flowers, coffee, vanilla, tea, etc.) [48] there was a mixed consensus (51% vs 49%), demonstrating an area for future research. There was also a low familiarity rate for the Foundation Earth Eco-label; however, this finding could be expected, as this is a relatively new symbol scheme currently located mainly on plant-based alternatives [49]. In addition, we checked whether children could write down the appropriate meaning, and it appeared that the majority of children, regardless of the symbol, were unable to jot down correctly the right response. Therefore, it could be suggested that asking children to write down the answer rather than use multiple choice may be a more representative measure in understanding children's knowledge. More broadly, there is evidence of widespread misconceptions and concerns over transparency relating to sustainable food-based symbols globally; hence, calls for a standardised system could be received favourably by consumers [50].

Children's responses from six food-packaging disposal and nine symbol-related questions were combined to give an overall performance score as both elements are likely to be interrelated and overlap to some extent. It was apparent that 76% of children scored between five and nine correct responses from fifteen questions, suggesting room for improvement in children's food-packaging disposal and symbol knowledge. This implies that utilising a broad approach that encompasses all food packaging aspects, from interpreting the package via understanding symbols to appropriate disposal, could help result in a step change, subsequently supporting children more easily adopting sustainable behaviours. Going forward, more emphasis on including such topics within the school curriculum could be fundamental in helping to improve compliance.

4.3. Food Packaging Issues and Preferences

Understanding children's issues and preferences can help to improve engagement and enable a more tailored approach in the future. It was clear that children cited excessive packaging and full bins as fundamental food-packaging issues. Interestingly, similar findings have been found in UK based children and adult cohorts; therefore, suggesting that food companies need to do more to reduce food-packaging levels via improved trans-

parency, added value, and more circularity, coupled with infrastructure changes, in order to overcome such factors [4,8,9,14,37]. Moreover, Tobler et al. [51] noted consumers identified excessive packaging as having a noteworthy environmental impact, correspondingly resulting in a negative connotation. In addition, it is important to understand where children search for food-packaging information so that appropriate resources can be created. Children cited labels-on-pack and digital tools (e.g., search engines and mobile apps) as main searching sources, highlighting the growing digital focus of this age group [37,52]. Thus, such findings provide useful design elements for future digital educational materials.

4.4. Current and Future Behaviour

It is useful to gauge current sustainable approaches adopted by children so that areas for improvement can be identified. Overall, only 51% of the children followed such practices, namely key ones including recycling, reuse, refill, not littering, and energy efficiency. This finding aligns with the recent report by Deloitte [8] noting recycled or composted household waste, reduced food waste, and limited single-use-plastic as consumers' most common approaches utilised in the past year. Therefore, future work should focus on engaging children that are not currently adopting sustainable practices and understanding their barriers, as this could have notable societal impact. Moreover, it is likely that affordability and lack of interest and/or information could be key drivers in successful uptake [8]. Positively, over three-quarters of the children were interested in improving their food-packaging behaviour, which is very promising. It is important that engagement strategies take into consideration key themes such as how to help the environment, making it clear and easy, improved labels-on-pack and recyclability, understanding the impact and consequences, as well as more educational and public campaigns to help promote future everyday sustainable behaviour. Moreover, ensuring such topics are covered in the school curriculum is key, as well as providing incentives to adopt good practices at an individual and population level. For example, support with applying for recognised environment-based schemes like the 'Eco-Schools Green Flag Award' [53]. Accordingly, future work should focus on tracking everyday food packaging-related behaviour in different settings (e.g., on-the-go, at-home, and at-school) to improve ecological validity over the short and long term in order to better understand compliance utilising digital educational tools to maximise impact.

This research was conducted in an ecologically valid setting (e.g., outside the classroom and away from external pressures such as teachers, parents, or guardians) providing valuable insights that can be missed in the classroom and/or at-home-based activities. Positively, children were involved to varying extents from all key stage groups; however, future work should aim for balanced quotas across the different ages to enable additional analysis. In addition, conducting research capturing all school-year groups and perhaps running a competition across the year to increase and sustain engagement levels; thus, enabling a larger cohort and subsequently increasing the sample sizes. Similarly, children were mainly London-based or from the surrounding areas (e.g., Hertfordshire, Kent, Surrey, and Hampshire); therefore, predominately the children were from the southeast region. However, it is likely children will still encounter different kerbside recycling systems since there are approximately 39 different bin regimes in the UK [6,14]. Going forward, increasing the geographical spread to children across all regions of the UK would be important so as to understand the full extent of the problem. It is also important to learn lessons from other countries; therefore, incorporating a cross-cultural perspective could be useful to help understand the role of infrastructure on subsequent behaviour and engagement levels.

5. Conclusions

This paper aimed to test different interactive activities capturing different aspects of sustainable food packaging in an ecologically valid setting, and it demonstrated mixed engagement and limited knowledge levels. For example, children had positive initial disposal knowledge; yet, this translated into relatively poor implementation, especially

for dirty food items (such as pizza box and mayonnaise bottle). Similarly, there were mixed awareness levels relating to different food-packaging symbols knowledge. Overall, improving food-packaging disposal and symbol knowledge is a key area for future work, coupled with a call for standardisation and simplification to improve engagement at the population level. It is important that any suggested approach is tailored to children; accordingly, an emphasis on accessible information in a digital format could be fundamental to promote compliance. It is encouraging that most children were interested in modulating future behaviour; therefore, utilising environmental, recyclability, impact/consequences aspects coupled with improved labelling in a clear and easy way are considered key. Moreover, incorporating the importance of sustainable food-packaging practices into the school curriculum at an early age (e.g., primary school) and improved infrastructure across the UK could result in children implementing appropriate practices into their everyday life.

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Informed Consent Statement: Informed consent was obtained from all children involved in the study.

Data Availability Statement: The data presented in this paper are available on request from the corresponding author.

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