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RECYCLE-REUSE-REDUCE: Developing sustainable food packaging toolkits for school-aged children in Poland and Spain – A pilot study

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ABSTRACT

Engaging future generations in sustainable initiatives is fundamental; accordingly, children need relevant education from an early age. This paper investigates the role of repeated exposure to interactive, creative and practical activities on subsequent awareness of sustainable food-based practices in two countries, Poland and Spain. Children (n = 89; 9–12 years) completed a series of activities centred around recycle, reuse and reduce "The 3Rs concept" coupled with surveys to quantify changes in knowledge pre and post activities. Overall, it was evident that children had relatively high environmental awareness and cited key sources of information as school and television. The activities were effective at increasing engagement with sustainable topics and practices. Sustainable behaviours increased: at school grounds mainly with waste disposal (sorting and recycling), daily practices outside school tapped into general environmental behaviours (saving resources, reducing waste), and disposal practices (sorting). Next steps will involve developing children-centric toolkits, measuring impact in different settings and encouraging uptake of everyday sustainable practices in children.

SPECIFICATIONS TABLE (All sections are mandatory unless marked otherwise)

Subject area	3315 – Communication
Category/categories of societal impact	Education Environmental Societal
Sustainable Development Goals (SDGS) the research contributes to	*GOAL 4: Quality Education* *GOAL 9: Industry, Innovation and Infrastructure* *GOAL 11: Sustainable Cities and Communities* *GOAL 12: Responsible Consumption and Production*
Related published article	V. Norton, O.O. Oloyede, S. Lignou, Q.J. Wang, G. Vásquez, N. Alexi, N., Understanding consumers' sustainability knowledge and behaviour towards food packaging behaviour to develop tailored consumer-centric engagement campaigns: a Greece and the United Kingdom perspective, J Clean Prod. 408 (2023) 137169. https://doi.org/10.1016/j.jclepro.2023.137169. V. Norton, N. Alexi, A. Contente, S. Lignou., The 3Is: Let's involve, inform and inspire the next generation on disposing food packaging sustainably, J Clean Prod. 424 (2023) 138807. https://doi.org/10.1016/j.jclepro.2023.138807. V. Norton, O.O. Oloyede, N. Alexi, A. Menil, G. Ren, N. Jadhav, S. Lignou. Investigating students' food packaging-related challenges and preferences in Europe and Asia, Sustainability 16(12) 5185. https://doi.org/10.3390/su16125185.
Research Projects	InformPack: Development of public engagement actions, tools and strategies to enable a sustainable shift in food packaging culture in Europe – funded by the European Institute of Innovation & Technology – EIT Food (grant number: 22205). Project Website: https://www.eitfood.eu/projects/informpack The 3Is: Let's involve, inform and inspire the next generation on disposing food packaging sustainably – funded by the European Institute of Innovation & Technology – EIT Food (Small projects for Impact grant).
Stage of research	***In Progress***

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Societal impact

Sustainability is a fundamental multi-dimensional concept which captures economic, social and environmental aspects as well as focuses on the present to ensure a better future for all [1]. Therefore, engaging the community on how best to implement different sustainable activities is key; however, substantial change is needed to shift behaviour and overcome associated barriers which range from insufficient knowledge to infrastructure challenges [2,3]. Environmental awareness needs to be embedded from an early age [4]; thus, activities that foster curiosity in a food packaging context and utilising targeted education could be a feasible solution.

It is evident that primary school children represent a cohort at a noteworthy developmental stage to engage in environmental matters and increase their awareness in this area [4]. The school settings also provide an opportunity to learn appropriate practices away from family members; thereby, encourage "pester power" in the household (or other settings) on topics of interest [5]. Exposing school-aged children to different approaches for decreasing food packaging waste could have a widespread impact for shifting everyday practices. For example, recycle (your packaging material in the relevant bin), reuse (your items such as containers and water bottles) and reduce (your waste by avoiding excess packaging and purchasing "loose" fruit and vegetables) can be defined as "The 3Rs" [6]. This concept could help to provide children with building blocks to implement sustainable food packaging behaviour. From a packaging perspective, there is a range of factors to consider from materials, design cues, environmental impact to food safety [7]; therefore, children need sufficient awareness to understand how to quickly synthesise information from the pack to enable correct disposal in different settings. Otto and Pensini [8] noted the importance of environmental education in terms of addressing children's ecological behaviour. Accordingly, a series of activities (e.g., worksheets, activity booklets, discussions, presentations, competitions, etc.) in this context were developed to increase environmental awareness utilising input from previous work in the UK but adapted to ensure cultural relevance for Poland and Spain [3,9].

This proof-of-concept research aims to investigate the role of interactive, creative and practical activities on subsequent knowledge and awareness of sustainable food-based practices. The overall goal is to collate activities of interest so that the toolkits can be developed for schools and households for different target populations. This is an overriding objective of the "InformPack" project so as to create public engagement actions, tools and strategies to enable a sustainable shift in food packaging culture in Europe. In addition, it is fundamental to increase awareness among children on the Sustainable Development Goals as well as providing context and demonstrating the importance of sustainable food-based activities [1]. For example, this research contributes to four goals:

Goal 4: quality education – fostering curiosity on the topic from a young age

Goal 9: industry, innovation and infrastructure – initiate conversation to encourage change

Goal 11: sustainable cities and communities – promote everyday sustainable behaviours

Goal 12: responsible consumption and product – children are users of food packaging so need to adopt appropriate practices

Methodology

Schools from Poland (Stawiguda) and Spain (Málaga) interested in environmental sustainability were invited to partake in a series of interactive activities (over a two to three-month period) centred around "The 3Rs concept" (Fig. 1). Eighty-nine children (aged 9–12 years; 47.5 % female, 38.5 % male and 14.0 % other) from grade four to six engaged in food packaging related quizzes, games, discussions, creative/practical tasks, watched videos and listened to presentations. The

Fig. 1. Summary of the "The 3Rs concept" (i) **stage one:** pre-survey (n = 89) focused on the environment, sources of information, current practices, willingness to adopt sustainable behaviours and food packaging disposal awareness (all questions were yes or no, multiple choice, check-all-that-apply (CATA) or agreement scales); (ii) **stage two:** school visits on **recycle**, **reuse** and **reduce** which implemented interactive (quizzes, games, videos, presentations, discussions), creative (decorate a lunch box, water bottles and/or eco-bag) and practical (hide/seek with different food items) activities as well as trips (waste facility or bench/river clean up); and (iii) **stage three:** post-survey (n = 85) to evaluate impact using the same survey as stage one).

activities were delivered in Polish and Spanish to be culturally relevant and translated from English using the "double-back-approach" [3]. Children also visited a waste facility (Poland) or collected waste during a beach/river clean-up (Spain) to provide real-world examples as well as raising environmental awareness and giving context for the school visits. The sample size was considered sufficient to capture initial insights and identify key trends to inform future research [10]. In addition, relevant informed consent was received from parents and/or guardians prior to the school visits and children were asked orally if they were willing to participate. The activities were carried out in accordance with the Declaration of Helsinki and received a favourable opinion for conduct from the Institutional Review Board of the Aarhus University's Research Ethics Committee (Journal nr. 2024–0675083). The data was collected in paper-format aiming to foster curiosity and promote engagement levels utilising text and images to ensure suitability for this age-group [9,11]. Data analysis was conducted via XLSTAT version 2023.3.1 (New York, USA) using a Mann-Whitney test, test of two proportions and Cochran's Q test to quantify changes pre and post workshops ($p < 0.05$ was used for the significance level).

Results and implications

Overall, designing targeted interactive, creative and practical activities on "The 3Rs" had a positive effect in most cases on children's learning and reinforced key concepts. Key findings are summarised in Fig. 2. It was evident that children (at least 92 %) had relatively high environmental awareness and were informed on such issues. This finding is in line with the literature suggesting children aged 7–10 are at a pivotal timepoint for learning environmental attitudes and behaviour; therefore, research needs to capitalise on this to maximise impact [4]. Children cited school (79 %) and television (69 %) as dominant information sources for understanding environmental issues ($p < 0.0001$). This emphasises the importance of the surrounding environment driving accessibility to relevant information in this cohort and highlights the role of school-based education and social context in gaining knowledge.

Children were more willing ($p < 0.05$) to partake in sustainable initiatives (subject at school: 31.5 % vs 61.2 % and use less resources: 40.4 % vs 58.8 %) post workshops. Children also had greater agreement ($p < 0.05$) with sustainable statements relating to reducing single-use-plastic (44.2 % vs 61.9 %), food packaging related education (45.3 % vs 64.3 %) and bioplastics (31.0 % vs 51.2 %) post workshops. This supports previous research in primary schools that interactive activities are effective at promoting interest and engagement levels relating to sustainable food packaging as well as the benefits of environmental derived education for this age-group [8,9]. Education was effective (pre: 13.8 % vs post: 32.9 %) at improving appropriate practices for dirty food items ($p = 0.006$); however, there is still room for improvement. Interestingly, cleaning prior to food packaging disposal (e.g., when and what) has also been cited as an area for additional clarification in children and adults [3,9]. Going forwards, ensuring such topics are included in primary school curriculums regardless of country is paramount so that best practices can be developed at a young age.

Children (at least 75 %) were regularly adopting sustainable behaviours at school such as using sustainable containers and sorting food packaging. This is a positive finding and demonstrates that schools are trying to encourage appropriate practices. Daily practices varied by location; for example, children often avoided unnecessary food waste (70–81 %). However, children were less often reducing litter (40.5 % vs 91.8 %), saving resources (34.5 % vs 77.6 %) and sorting food packaging (60.7 % vs 69.4 %) at-school compared with outside of school (e.g., at-home). This is a key area for future research to identify ways to increase engagement levels in all locations. "Pester power" (children as agents of change) could be a reason for the improved compliance in household settings; however, this requires sufficient knowledge from the children to implement [5].

The same guide was used for the activities development in both countries; however, the specific content was not fully identical. This may have introduced a limitation for direct comparison but this ensured the activities were adapted to meet the country-specific needs and helped to increase relevance to the local setting as well as strengthening the overall impact of the designed activities.

In summary, developing activities with interactive (quizzes, games, videos, presentations, discussions), creative (decorate a lunch box or eco-bag) and practical (hide/seek with different food items) elements was effective at promoting curiosity as well as increasing awareness of sustainable food-based practices. This insight will be fundamental in

Fig. 2. Overview of key findings by theme.

highlighting relevant design cues for future toolkits. Additional research is needed using larger cohorts of children (varying in age) from more schools and countries across Europe to understand cultural differences to ensure a more tailored approach can be implemented so that comprehensive mapping analysis can be conducted. In addition, reviewing the impact of various activities in the short and long-term in different contexts (school, household and on-the-go) is key to successful shifting everyday behaviour. Modulating children's behaviour in isolation will not solve the global sustainability challenge; thus, it is important to work collaboratively with different stakeholders and partners (such as schools, local authorities, government, brand owners, retailers) to help meet the Sustainable Development Goals for a better future.

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CRediT authorship contribution statement

Victoria Norton: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Formal analysis, Data curation, Conceptualization. **Stella Lignou:** Writing – review & editing, Visualization, Validation, Supervision, Software, Formal analysis, Data curation, Conceptualization. **Angela Magno Malagón:** Writing – review & editing, Resources, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Joanna Fotschki:** Writing – review & editing, Validation, Resources, Methodology, Investigation, Data curation, Conceptualization. **Marta Kopcewicz:** Writing – review & editing, Resources, Methodology, Investigation, Data curation, Conceptualization. **Iwona Kieda:** Writing – review & editing, Validation, Resources, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Geraldine Vásquez:** Writing – review & editing, Validation, Project administration, Methodology, Data curation, Conceptualization. **Konstantina Sfyra:** Writing – review & editing, Validation, Project administration, Methodology, Data curation, Conceptualization. **Niki Alexi:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Ethical statement

The activities were carried out in accordance with the Declaration of Helsinki and received a favourable opinion for conduct from the Institutional Review Board of the Aarhus University's Research Ethics Committee (Journal nr. 2024–0675083).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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