

Article

Educating Young Consumers about Food Hygiene and Safety with SafeConsume: A Multi-Centre Mixed Methods Evaluation

Magda Hann ^{1,*}, Rosalie Allison ¹, Mónica Truninger ², Luís Junqueira ^{2,3}, Alexandre Silva ², Pia Touboul Lundgren ⁴, Virginie Lacroix Hugues ⁴, Marion Godard ⁴, Ágnes Fehér ⁵, Eszter Csenki ⁶, Dávid Szakos ⁵, Gyula Kasza ^{5,6}, Neville Q. Verlander ⁷, Gina Chen ¹ and Alicia Demirjian ^{1,8,9}

¹ Primary Care and Interventions Unit, Healthcare Associated Infections, Fungal, Antimicrobial Resistance, Antimicrobial Use and Sepsis Division, UK Health Security Agency, Gloucester GL1 1DQ, UK

² Instituto de Ciências Sociais, Universidade de Lisboa, 1600-189 Lisboa, Portugal

³ Centro de Investigação e Estudos de Sociologia (CIES-Iscte), Iscte-Instituto Universitário de Lisboa, 1649-026 Lisboa, Portugal

⁴ Département de Santé Publique, Hôpital de l'Archet 1, rte St Antoine de Ginestière, 06202 Nice, France

⁵ Department of Veterinary Forensics and Economics, University of Veterinary Medicine Budapest, 1078 Budapest, Hungary

⁶ National Food Chain Safety Office, 1078 Budapest, Hungary

⁷ Statistics, Modelling and Economics Department, UK Health Security Agency, London NW9 5EQ, UK

⁸ Evelina London Children's Hospital, London SE1 7EH, UK

⁹ King's College London, London WC2R 2LS, UK

* Correspondence: magda.hann@ukhsa.gov.uk



Citation: Hann, M.; Allison, R.; Truninger, M.; Junqueira, L.; Silva, A.; Touboul Lundgren, P.; Lacroix Hugues, V.; Godard, M.; Fehér, Á.; Csenki, E.; et al. Educating Young Consumers about Food Hygiene and Safety with SafeConsume: A Multi-Centre Mixed Methods Evaluation. *Educ. Sci.* **2022**, *12*, 657. <https://doi.org/10.3390/educsci12100657>

Academic Editor: Kelum A.A. Gamage

Received: 10 August 2022

Accepted: 1 September 2022

Published: 28 September 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract: The SafeConsume educational suite was designed to improve knowledge about undertaking safer food practices and avoiding food-borne illnesses among young people. The resources were designed to support educators and members of the community who teach young people (aged 11–18 years) and include lesson plans and supporting teacher training resources. To assess the efficacy and suitability of the resources, an evaluation of the central lesson, the 'user journey', was conducted within four European countries. The mixed-methods evaluation included the following elements: a pre- and post-scenario-based questionnaire, a satisfaction questionnaire, focus groups with students; and interviews with teachers. Data from the scenario-based questionnaires were analysed using a mixed effects normal linear regression model. Qualitative data were thematically analysed, and the main themes were discussed. A total of 171 students and 9 educators took part from schools based in Portugal, Hungary, France and England. The results indicated a significant improvement in students' knowledge and understanding of appropriate food hygiene practices overall, although this varied among countries. The resources were found to be well-suited to help teachers deliver the lesson, being considered by teachers to be both informative and flexible. Minor alternations were suggested, including alterations to lesson delivery or breaking the lesson into smaller sections, and increasing the lesson's interactivity.

Keywords: teach; qualitative; quantitative; schools; knowledge; research; food safety; food poisoning; foodborne illnesses; cooking; food technology; prevention



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Foodborne illnesses pose a significant burden to health in all parts of the world; estimates from the World Health Organisation (WHO) European Region alone indicate that 23 million people experience illness related to eating contaminated food every year [1]. It is estimated that this results in 5000 deaths per year and 400,000 disability-adjusted life years; however, limitations in surveillance and reporting mean levels likely exceed this [1,2].

Previous research with children, young people and university students across Europe, Turkey, Iran, Kuwait and USA suggest a lack of knowledge, concern, perceived susceptibility to foodborne illness [3–10], as well as a lack of awareness of the role of

microorganisms [11,12]. This seems unsurprising, considering educators report a lack of confidence or capability to teach food microbiology and foodborne illness topics [13]. Research that highlights the limited comprehension of risks and consequences of foodborne illness and the necessary steps to ensure food safety suggest poor food safety behaviour is common [7]. Considering children and young people are active in the kitchen [3,7], learning about food safety during adolescence should be considered pertinent and necessary. In fact, gaining cooking skills at an early age is found to be important in adult skill retention, confidence, and attitude [14]. Adolescence is the point at which cognitive structures reach a developmental peak, making this time crucial for developing knowledge, skills, and habits, including those related to food safety [15]. Such evidence suggests education can provide a meaningful impact on future food safety behaviour [16].

Successful behaviour change interventions should aim to have a robust evidence base [17], but a scoping review that assessed the effectiveness of food-safety educational interventions found only one quarter had a basis in behavioural science [18]. Many educational programmes aimed at school-aged children are instead designed specifically to address predefined learning outcomes or fit into national curricula [19,20]. While this is an important factor in implementation, successful interventions should aim to account for the many determinants of behaviour, of which knowledge is only one [21,22]. Other determinants less commonly addressed include social influence; reinforcement; intentions; beliefs about consequences, environmental context and resources. Additionally, greater support for educators is also required in order to support confidence in teaching food safety topics [13,23].

1.1. SafeConsume User Journey Lesson

SafeConsume (www.safeconsume.eu accessed on 9 September 2022) is an EU Horizon 2020-funded transdisciplinary research project, which aims to reduce the burden of foodborne illness. The project combines multiple workstreams, bringing different perspectives to behaviour change, with some focused on individual behaviours and informed by psychological and behavioural science perspectives, and others focused on social practices, drawing on sociological and practice theory approaches to eating [24]. This study belongs to the workstream dedicated to developing educational resources to support those teaching 11–18-year-olds [25], which is now hosted on the e-Bug website (www.e-Bug.eu, accessed on 9 September 2022).

Seven individual teaching resources were developed through the SafeConsume project [25]. This paper will evaluate the central resource, the “user journey”, which is comprised of the following:

- Teacher-led slide deck,
- Food safety animation,
- Instructional teacher sheet,
- Student worksheet to be completed during the lesson.

The lesson describes the journey of a typical consumer, including meal planning, shopping, packing, transporting, storing food, food preparation, cooking and storing leftovers. The resources provide education on food microorganisms, hygiene and cross-contamination, storing food to reduce microbial growth, appropriate cooking temperatures and understanding food labels. All resources were designed for use in an educational setting, were linked to the national curriculum in each of the partnered countries, and fit into a 50-min teaching session.

The two teacher training resources designed to support the lesson were also evaluated and included the following: session 2 (microbiological aspects); and session 4 (infection transmission).

This research took place in four European countries, France, Portugal, Hungary, and England, during the challenging and fluid context of the COVID-19 pandemic in early 2020. This evaluation was designed to adapt to different feasibility conditions in each country, as

a result of the differences in curriculum, teaching conditions and access to schools, as well as country-specific pandemic restrictions.

1.2. Aim

The aim of this study was to evaluate the efficacy and adequacy of the primary SafeConsume teaching resource, the “user journey”, to teach young consumers about food hygiene and safety, in four European countries. A second focus was to assess the adequacy of the teacher training materials to support educators.

2. Methods

2.1. Research Design

This study used mixed methods, including the following:

- Quantitative: pre-and post-students’ scenario-based questionnaires (Supplementary SA).
- Qualitative: lesson observation (Supplementary SB); educator interviews (Supplementary SC); and post-intervention student satisfaction class discussion or questionnaire (Supplementary SD and SF).

Due to the varying restrictions related to the COVID-19 pandemic at the time of evaluation, variations in the protocol were required in each of the four countries involved (Table 1).

Table 1. Summary of protocol used to evaluate the SafeConsume “user journey” lesson, in each participating country.

	Intervention Delivery	Pre- and Post-Questionnaire	Student Satisfaction	Educator Interview
France	✓ Classroom	✓	✓ Questionnaire	✓
Hungary	✓ Classroom	✓	✓ Questionnaire	✓
Portugal	✓ Classroom	✓	✓ Class discussion	✓
England	✓ Online	✓	✓ Questionnaire	✓

2.2. Sampling and Recruitment

We sought to recruit an adequate sample size to show significant differences in the score achieved using a 35-point questionnaire. Power calculations were used, seeking a 5% significance level with a 5-point increase; each country aimed to recruit a minimum of 25 students, through convenience sampling.

The resulting sample across all countries contained more students in the 11–14 age group (65.5%) compared with the 15–18 age group (34.5%). The gender distribution leaned towards female (54.7%), with a small number of students identifying as other genders (2.5%). Some students (22.0%) did not answer the question on their guardian’s education level. Among those that did, the parent’s education level was high, with 80% (or 62.3% of total) having completed a tertiary education. Schools were predominantly urban, with one suburban school in Hungary and one rural school in England and a balanced mix of high and low socioeconomic status.

Students and their educators were provided with information sheets to inform them about their rights to withdraw their participation at any time. Parental consent forms were provided to any student under the age of 16 and students over the age of 16 provided their own consent, collected prior to the lesson commencing.

2.3. Data Collection

2.3.1. Pre- and Post-Intervention Students’ Scenario-Based Questionnaire

A 20-item questionnaire combining true, false, multiple choice and open-ended questions based on common food handling scenarios was agreed by researchers. Due to the different guidelines around egg production across Europe, some countries included an additional question about handling eggs.

Most students completed a paper version of the questionnaire, while students in England completed electronic questionnaires, due to school closures caused by the COVID-19 pandemic. Due to time constraints, students completed the pre-questionnaire within the 7 days before the user journey lesson, and the post-questionnaire within the 7 days after.

Questionnaires were scored based on the number of correct and incorrect answers given, and the results inputted into EpiData software [26]. The students were given anonymised codes, assigned by their educator, to match the pre- and post-scores.

2.3.2. Lesson Observations

The lesson was delivered by educators known to the students, with existing science backgrounds, and observed by researchers either in person, via audio recording, or by observation of online teleconference teaching. Researchers made notes on fidelity of implementation and students' engagement, using a standardised template.

2.3.3. Student Satisfaction

Due to time constraints and access to schools, either a class discussion or a satisfaction questionnaire was used with students, to collect feedback on the lesson.

2.3.4. Teacher Interviews

The interview schedule was developed to discuss the educators' experiences of using the teaching materials and supporting teacher training resources. This included confidence to teach the subject before and after the use of resources, student response to lesson, and specific recommendations for improvement of any of the given resources. Semi-structured interviews were conducted either in person, via telephone or via teleconference software in each country by one or two researchers.

2.4. Data Analysis

2.4.1. Scenario-based Questionnaires

To compare the pre- and post-intervention students' scenario-based questionnaire scores, a mixed effects normal linear regression model was used to analyse student data. For this, pupil data were nested within classes, nested within the school as random effects, and the total score used as the outcome. By random allocation, France (pre) was used as a baseline. The model used "phase" (pre/post) and "country" as fixed effects and adjusted for "gender" and "age group", with the interest focused on the adjusted estimate and 95% confidence interval (CI) of the phase coefficient. Stata version 16.1 [27] was used for the analysis.

In the analysis, interaction between "country" and "phase" was considered and tested. If found significant at the 5% level, it was retained, or otherwise removed. If retained, the effect by country compared to pre-intervention for one of the countries was presented. Otherwise, the effect is the overall change. This analysis excluded non-comparable data, including a question about egg conservation and one other question that was affected by an inputting error.

2.4.2. Qualitative Analysis

In England, the interviews were recorded, transcribed verbatim and checked for accuracy against the recordings by researchers. NVivo Pro 11 software, QSR International Pty Ltd. (Doncaster, Australia) was used to sort the data, including the analysis of codes, quotes, and themes. One researcher analysed the dataset and a second and third researcher double coded 10% of the data. Data were analysed using an inductive six-stage thematic analysis, whereby patterns of meaning are identified and coded within the data [28]. Analysis from the four participating countries was then inputted into a thematic grid, and further analysed for common themes and areas of difference between the countries.

3. Results

A total of 171 students participated in the SafeConsume User Journey lesson and completed pre- and post-scenario-based questionnaires in the four countries involved (Table 2).

Table 2. Breakdown of students who completed before and/or after student scenario questionnaires, by age group and country.

Participant/Country	France	Hungary	Portugal	England	Total
11–14 years	48	31	0	21	100
15–18 years	0	10	40	21	71
Total students	48	41	40	42	171
Educators	2	2	2	3	9

3.1. Quantitative Analysis

Scenario-Based Questionnaires

Pre- and post-intervention student knowledge questionnaires (Figure 1 and Supplementary SF) show an overall improvement in students' scores from pre- to post-intervention, although this was not statistically significant in all countries.

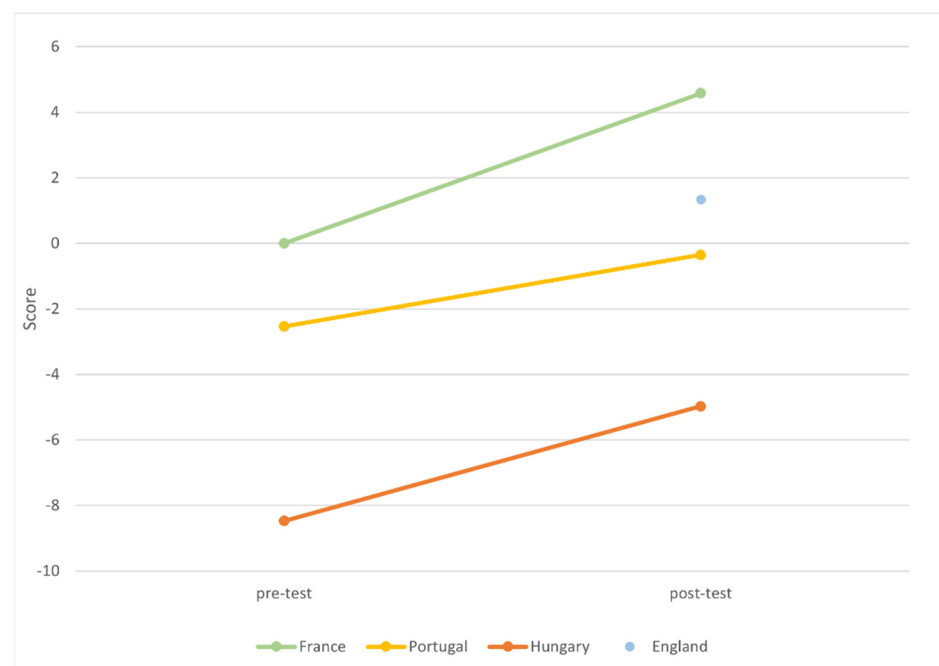


Figure 1. Estimated student questionnaire scores pre- and post-delivery of SafeConsume user journey lesson (adjusted based on age and gender). Note: France pre-taken as baseline.

Hungary, Portugal, and England scored highly during the pre-knowledge questionnaires. Analysis 1 shows a significant difference in the pattern of improvement observed with a p -value < 0.05 . France achieved the largest improvement, and a smaller improvement was observed for Hungary and Portugal. England achieved a smaller improvement, and the model was unable to calculate an estimate for the pre-intervention, meaning the significance of the change in score from pre to post in England could not be determined.

3.2. Qualitative Data

3.2.1. Fidelity of Implementation

Fidelity of implementation varied greatly between schools and countries, due in part to the diversity of teaching environments and pressures on educators caused by the COVID-19 pandemic (Table 3). Each research team advised teachers to use the resources provided as they wished, to assess the requirement and relevance of each. As a result, the resources were utilised to a greater or lesser extent in many countries.

Table 3. Breakdown of intervention components used with each class.

Class	France		Hungary		Portugal		England		
	A	B	A	B	A	B	A	B	C
Slide deck lead lesson	X	X	✓80 mins	✓60 mins	✓	✓	✓80 mins	✓	✓ (blended learning)
Teacher Sheet	✓	X	✓	✓	X	✓	✓	✓	✓
Worksheet	✓	X	✓	✓	✓	✓	✓	✓	✓
Animation	✓	✓	✓	✓	✓	✓	✓	✓	Unknown
Teacher training	✓	X	✓	✓	✓	✓	✓	✓	✓

Teaching time and lesson format was variable, an effect of the COVID-19 related school closures. Some classes in Hungary and England exceeded the standard 50-min teaching session and England school C used a ‘blended learning’ approach, in which students independently utilised the slide deck ahead of the lesson, before discussing in class.

3.2.2. Educators’ Views on the SafeConsume Education Resources

Teachers’ responses to the lesson were largely positive. They found the materials provided to be useful and they reported that students were interested and motivated to participate, to a large extent. Whilst all teachers used the resources in different ways, they reported finding the slide deck the most important resource for planning the lesson and reported that the resources could be used flexibly. The animation was the most liked element of the resources, and teachers reported that they would welcome the inclusion of more of this kind of resource.

The teacher training sessions were described as informative and complete, and teachers reported they boosted their confidence to teach the material. However, differing opinions were shared regarding the suitability of the resources for non-specialist educators, some suggesting that the resources would be of particular use to non-specialists, while others suggested they may be difficult to navigate due to the large amount of information, and therefore off-putting. Teachers’ suggestions for improvements included the following: alteration to the running order of the slide deck and amount of content; more interactive elements; native language voiceover in the animation for non-English audience; simplification of the worksheet; clarified instructions for accessing and navigating teacher training; simplified teacher training; and more videos and animations. These themes have been detailed in Table 4.

3.2.3. Reported Views of the SafeConsume Education Resources: Students

The students that provided feedback via the satisfaction questionnaire were first asked to describe the lesson by choosing one or more of the following options: ‘interesting’, ‘keeps you thinking’, ‘difficult’ or ‘boring’. The positive feedback outweighed the negative in all countries bar Hungary, in which ‘boring’ was selected by more students than ‘keeps you thinking’ (Figure 2).

The qualitative opinions gathered both via student satisfaction questionnaire and class discussion showed an overall positive experience. Students regarded the lesson as age appropriate, reporting that it was an important subject and relevant even to younger age groups. Students across all countries cited the animation to be the most liked element of the

lesson, although in all non-English speaking countries, it was criticised for being English with subtitles. Students in these countries also reportedly found it to be childish, due to the animated style but said that this would not make them less interested in it. Students widely reported that the visual aspects of the lesson improved engagement, citing both the slide deck and animation; some students believed that the lesson could have been further improved with the inclusion of more of these visual elements.

Table 4. Thematic finding from teacher interviews: improvements to the powerpoint, animation, student worksheet, and teacher training resources.

Theme	Main Finding	Quote
Lesson formatting changes	Teachers had the following suggestions for improvements that could be made to the structure and delivery of the slide deck: <ul style="list-style-type: none"> • Edit slide order to allow more time for discussion; • Reduce size of slide deck or suggest teaching over two lessons. 	“It would be nice to divide the course into different parts with one part on shopping and tidying and another part on cooking with hygiene and cooking” (FR)
Inclusion of interactive elements	Some teachers said they would have benefited for more interactive activities perhaps online games.	“To suggest internet links with a game to do at home with a final score to improve.” (FR)
Native language animation voiceover	Teachers enjoyed the animation in all nations; however, it was raised that the subtitles could be too fast or were difficult to read.	“The video needs to be translated into French because the subtitles are too fast, even us we had trouble reading it out loud.” (FR)
Worksheet changes	Worksheet was thought to be challenging for some students and could be simplified to provide better support.	“for some of the students, [it would be] easier if there was an alternative worksheet where there’s perhaps, I don’t know, multiple choice or things that they [draw a] ring round.” (EN)
Simplify teacher training	Too much information, especially for non-expert educators.	“I think the first Slide deck (microbiological aspects) would terrify some teachers, so I think the first PowerPoint probably has to be made a little bit more fluffy. Because it’s got a lot of detail on it.” (EN)
Clarify structure of teacher training	Teachers did not understand how to navigate slide deck as intended, resulting in underutilisation.	“The sessions are too much too long and with a lot of interesting information that requires a lot of sorting behind.” (FR)
Provide more videos and animations	Too much emphasis on use of slide deck, additional animations and videos would be welcomed.	“According to my experiences, student memorize visual inputs more easily as it might be challenging to maintain attention via the repetitive and very informative PowerPoint slides.” (HU)

Students enjoyed learning about the topic and found the resources to be informative, reporting that there were elements that could be implemented at home, such as checking the temperature on their fridge, separating meat and vegetables, cleaning their hands and surfaces more often, and discussing these aspects with their parents and family members.

Students’ criticism of the lesson included the following aspects: excessive reliance on writing, excessive content, a need for more interaction, insertion of native language voiceover in animation for non-English audience, trouble using technical terms and barriers to engagement with the teaching points used; these have been detailed in Table 5.

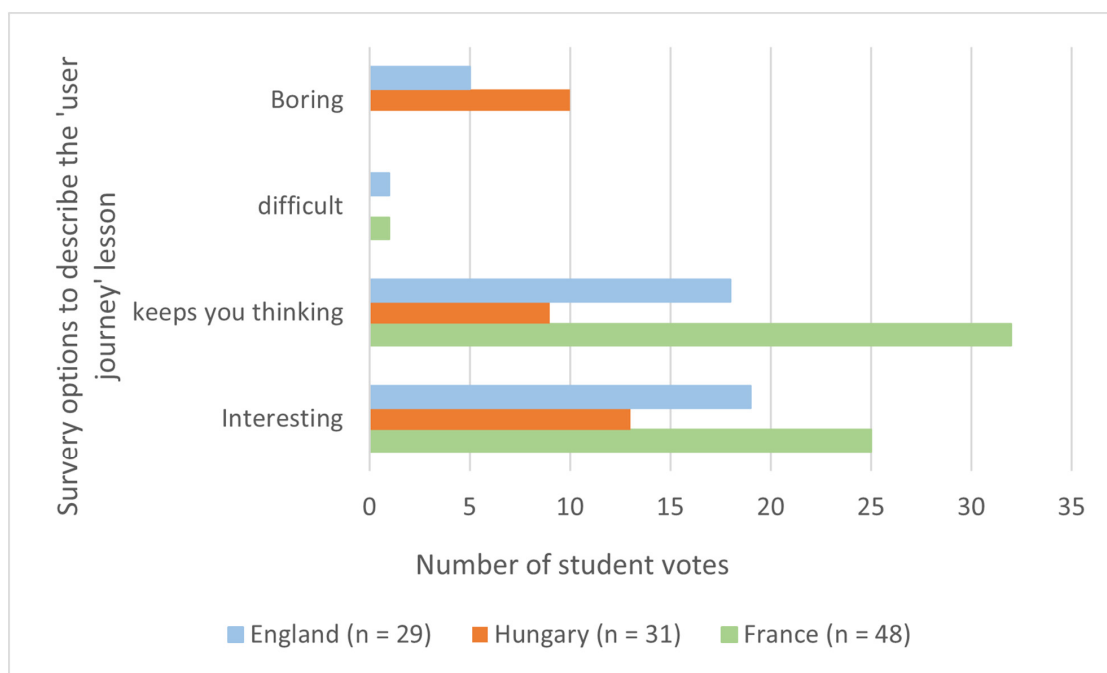


Figure 2. Student description of “user journey” lesson, collected as multiple choice from the options ‘interesting’, ‘keeps you thinking’, ‘difficult’ and ‘boring’.

Table 5. Thematic findings from student questionnaires; improvements to the lesson content, animation, and student worksheet.

Theme	Main Finding	Quote
Excessive reliance on writing	Students struggled with the worksheet format.	“Whilst it was being explained, large portions of text were being copied out onto the worksheet so it was hard to focus on the explanation.” (EN)
Excessive content	<p>Students reported struggling with the amount of overall content covered during the lesson in the following ways:</p> <ul style="list-style-type: none"> • Students reported lesson duration was too long; • Others reported not being able to process the amount of information provided in the lesson; • Some students expressed this positively, reporting that they would enjoy learning about the subject over more lessons. 	“Information being too tightly stored on one slide makes it difficult to interpret and less likely for me to remember, try to separate the information out more.” (EN)
More interaction needed	<p>Students in all nations reported the lack of interaction and desire for more interaction during the lesson in the following ways:</p> <ul style="list-style-type: none"> • Students wanted more quizzes to help them reinforce learning; • Some students wanted physical access to a kitchen; • Students in England reported that when the lesson was delivered over teleconferencing software, it was difficult to engage with the lesson because they could not interact with their classmates. 	<p>“instead of filling in the activity sheet, there could be a game or we could have used kahoot” (PT)</p> <p>“I would have liked to do it in a real kitchen”, “make big experiments.” (FR)</p>

Table 5. Cont.

Theme	Main Finding	Quote
Native language animation voiceover	Students in Hungary, Portugal and France found it difficult to follow subtitles used in the animation and would have preferred a voiceover.	(Regarding animation) “put a French version.” (FR)
Trouble using technical terms	Students reported having difficulty with some of the terms used, including specific language around types of illnesses and microbial names, affecting ability to engage.	“I didn’t know much about food hygiene.” (FR) “define the technical terms, such as different kinds of illness (symptoms).”(HU)
Not engaged with teaching points	<ul style="list-style-type: none"> • Some found the food safety points being taught difficult to implement, or not relevant to themselves. • Others disliked the messaging, saying that the points raised were negative, would have preferred things they ‘should do’. • Students primarily in England reported that the lesson was too similar to common sense, or that they had previously learnt that material. 	“Needs more practical advice. Needs more “positive” solutions (more than “don’t do X”).” (PT)

It should be noted that focus groups, rather than questionnaires, were used to collect feedback on the lesson in Portugal, so were not appropriate to include in this graph.

4. Discussion

4.1. Main Findings

The results of the scenario-based questionnaires indicated that the ‘user journey’ lesson, developed as part of the European-wide SafeConsume educational materials, was effective at increasing knowledge of food handling risks and safety practices in 11–18-year-olds.

France achieved the largest increase in knowledge from baseline to post-intervention; while the increase was less for Hungary, Portugal and England as the baseline knowledge of these countries was already high. All the students that participated in France were 11 years of age, making them the youngest group on average, although age was accounted for in the analysis. Lower initial knowledge scores could indicate that these students had gained less practical and social experience handling food in kitchens at home than their more senior peers. This could suggest that targeting food safety education at this age is of greater advantage, as this is the point at which many young people will be becoming more independent and active in the kitchen. Conversely, in England, the baseline knowledge of students was found to be high, and the improvement in knowledge score was not significant, while they achieved the highest post-lesson scores of the four countries. It is possible that these students benefited from hands on experience in school, where practical cooking lessons are commonplace.

Students’ and educators’ feedback was remarkably similar; both were positive about the resources generally, citing the animation as their most liked element. Suggestions for improvement also corresponded with this, with both groups identifying the worksheet as the element most in need of change, but also citing the need for more interaction through games and quizzes and a need to reduce the overall content. These results suggest that students’ and teachers’ requirements align, and what benefits the students, such as simplicity, and more easily understandable resources, would also benefit the educator.

4.2. Strengths and Limitations

Development of the SafeConsume resources drew from expertise and insight of researchers based in several European countries and should be considered a valuable resource for use across Europe. Initial information was gathered through the needs assessments

carried out in England, France, Hungary and Portugal [3,13], while the latter stages of development and refinement occurred in England and France [25], with input from Portugal, Hungary, Greece and Denmark. This process has demonstrated that context and culture vary greatly among countries, making designing a resource that is applicable in many countries challenging. However, this evaluation provides a positive indication that these two separate resources developed in England and France can be used effectively in the further contexts of Portugal and Hungary. While suitability of these resources in Greece and Denmark, where they have also been translated, cannot be known, we would argue that the comparable rates of knowledge increase observed provide indication for their success in other contexts. This may be further bolstered by the adaptation process conducted by each country, in which country-specific contexts and information were integrated into the resource.

This evaluation experienced unique challenges due to the COVID-19 pandemic that provided an unpredictable landscape, especially within the education sector, which was particularly affected by changes to the teaching environments and demands on students' and teachers' time. Although the numbers of participants in each country were modest, it should be noted that two or more classes were successfully recruited in each of the participating countries. Variance in school closures also affected the tools used for data collection, and while students used a mix of paper-based and online questionnaires, it was ensured that both were otherwise comparable. However, it is possible that those students that completed the knowledge questionnaires remotely could have accessed content to assist with answering, or benefited from more time to complete, affecting results.

To study the effects on behaviour, this evaluation originally aimed to collect observational data from practical cooking exercises; however, this was not possible due to the restrictions and social distancing in place. To account for this gap, researchers proposed collection methods to attempt to capture behavioural intentions or socio-cultural orientations to food safety practices, instead. The inclusion of scenario-based questions allowed the collection of students' perceptions of what practices should or should not be performed. It could be argued that this tool, which explored students' open answers to various practical food safety situations, may indicate self-efficacy, described as a person's recognition of their responsibility and capacity to carry out safe behaviour. Self-efficacy is often found to be a strong indicator for behaviour [29,30].

4.3. Comparison with Existing Literature

Systematic reviews and meta-analyses of food safety educational interventions have found that food safety training and courses can be effective at improving behavioural outcomes in children and young people; although the interventions in question included community-based workshops and web-based video games implemented in a classroom environment [16]. These examples provide a positive indication that school-based interventions can be an effective tool in enhancing food safety practices of young consumers.

One study conducted by Barrett and Feng [31] evaluated the use of two approaches, both designed using a behavioral foundation, one using the positive deviance model and the other, the experiential learning model. In a similar way to the present study, researchers used pre- and post-surveys and additionally, a further follow-up after one year. Overall, it was indicated that food safety knowledge was not sustainable one year on, but that risk-perception and perceived behavioral control were maintained in both conditions to a similar degree. To conclude, the study stated that regardless of the behavioral approach, interaction with educators and peers appeared to be important for learning about food safety. Similarly, in a review of food safety education for children [32], it was again identified that experimental or practical elements significantly improved the outcome of interventions. While it may be considered a limitation of the SafeConsume resources that they have not been designed with explicit hands-on opportunities, they have been designed for varied contexts where educational kitchens may not be available, and we would argue that they are flexible enough to be used in conjunction with practical experience, where possible.

The literature reveals a gap in the interventions that have been developed intentionally as a conventional lesson that would be appropriate for use in a national curriculum framework; many of those encountered evaluate full day, week-long or workshop-based interventions [19,20,30,31]. These studies are found to be successful in increasing knowledge of food-safety based concepts [19,30] and self-efficacy, which may indicate a positive impact on food safety behaviours [19]; however, they fail to consider the practicalities of implementation. This study adds to the literature that states that educational resources targeting food safety and hygiene that can be implemented in class time, within the national curriculum, can result in an improvement in knowledge, and potentially also in the practices of students in the kitchen.

5. Implications

The findings presented in this paper indicate that the ‘user journey’ lesson plan and associated teacher training resources are effective at significantly improving scenario-based knowledge. However, further research is required to investigate whether the knowledge is maintained or affects future food safety and hygiene behaviour among students. Additional work would also be required to ensure the efficacy and adequacy of the further four lesson plans and three supporting materials that have not been included in this study.

Given the shared desire for specific improvements that could be made to the resource, the following adaptations should be considered. To address issues with lesson timing, teacher instructions should give the option of the student worksheet being used as a group exercise to help students to work more quickly through the information and improve class interaction. Alternatively, the lesson could be broken into smaller sessions that cover the suggested sections ‘shopping and storing’ and ‘preparing, cooking and storing leftovers’. To further bolster interactivity, games or quizzes could be integrated, for which online platforms such as Kahoot [33] have been suggested by study participants. The students that referenced difficulties grasping technical terms would likely also benefit from these tools that support learning consolidation. Encouraging utilisation of teacher training resources would also improve educator support to students relating to technical terms. Although not possible in all countries, hands-on lessons in a kitchen would support ‘learning by doing’, where technical terms and actions are demonstrated live and in the real context of food preparation.

To enable greater adoption of these resources, efforts should be made to improve their desirability to students and educators by streamlining content and improving accessibility for non-English speakers, by providing a fully translated experience comparable to that provided in England. Public health authorities in England, France, Portugal, Hungary, Greece and Denmark should advocate for the use of the SafeConsume teaching resources as an evidenced-based, trustworthy source of food hygiene education that has been found to be successful in increasing food hygiene and safety knowledge among young people, a demographic at the point of becoming more independent and involved in their own food handling.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/educsci12100657/s1>, Supplementary SA: Scenario Based Questionnaire & Background Questionnaire; Supplementary SB: User Journey Lesson Fidelity Template; Supplementary SC: Teacher Interview Schedule; Supplementary SD: Student Focus Group/Class Discussion Schedule Supplementary SE: Student Satisfaction Questionnaire; Supplementary SF, Table S1: Pre- and post- intervention knowledge questionnaires: adjusted training effects and 95% CI.

Author Contributions: Methodology, R.A., P.T.L., V.L.H., M.T., A.D. and N.Q.V.; validation, G.C. and R.A.; formal analysis, M.H., M.T., L.J., A.S., Á.F., E.C., D.S.; investigation, M.G., M.H., M.T., L.J., A.S., Á.F., E.C., D.S., P.T.L. and V.L.H.; writing—original draft preparation, M.H.; writing—review and editing, R.A.; A.D.; M.T., P.T.L., V.L.H., G.K., L.J., A.S., Á.F., E.C. and N.Q.V.; visualization, G.C.; supervision, A.D. and G.K.; project administration, M.H., M.T., D.S. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 727580.

Institutional Review Board Statement: Ethical approval was received from each of the four country organisations prior to collecting data. Portugal’s agreement was granted by the Ethics Committee of the Instituto de Ciências Sociais, University of Lisbon, reference number 2019/25, for ethical clearance and data protection document. France’s data protection was registered with the Health Data Hub platform under reference R04-044. England secured approval from Public Health England Research Ethics and Governance Group (REGG) under reference (NR0242). In addition, Hungary secured approval from the Scientific Research Committee of the University of Veterinary Medicine Budapest. The research team requested the consent from all participants, teachers, students, and their guardians. Data were collected in line with the General Data Protection Regulation. Data were stored securely in adherence with each organisation/partner’s security practices.

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

Acknowledgments: We would like to thank the students and teachers who took part in this research, resource development and evaluation.

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

Abbreviations

England	EN
France	FR
Hungary	HU
Portugal	PT
World Health Organisation	WHO

References

1. WHO. *The Burden of Foodborne Diseases in the WHO European Region*; WHO Regional Office for Europe: København, Denmark, 2017.
2. Abbot, J.M.; Byrd-Bredbenner, C.; Schaffner, D.; Bruhn, C.M.; Blalock, L. Comparison of food safety cognitions and self-reported food-handling behaviors with observed food safety behaviors of young adults. *Eur. J. Clin. Nutr.* **2009**, *63*, 572–579. [\[CrossRef\]](#)
3. Syeda, R.; Lundgren, P.T.; Kasza, G.; Truninger, M.; Brown, C.; Lacroix-Hugues, V.; Izsó, T.; Teixeira, P.; Eley, C.; Ferré, N.; et al. Young People’s Views on Food Hygiene and Food Safety: A Multicentre Qualitative Study. *Educ. Sci.* **2021**, *11*, 261. [\[CrossRef\]](#)
4. Sanlier, N. The knowledge and practice of food safety by young and adult consumers. *Food Control* **2009**, *20*, 538–542. [\[CrossRef\]](#)
5. Unklesbay, N.; Sneed, J.; Toma, R. College Students’ Attitudes, Practices, and Knowledge of Food Safety. *J. Food Prot.* **1998**, *61*, 1175–1180. [\[CrossRef\]](#)
6. Green, E.J.; Knechtges, P.L. Food safety knowledge and practices of young adults. *J. Environ. Health* **2015**, *77*, 18–24.
7. Byrd-Bredbenner, C.; Abbot, J.M.; Quick, V. Food Safety Knowledge and Beliefs of Middle School Children: Implications for Food Safety Educators. *J. Food Sci. Educ.* **2010**, *9*, 19–30. [\[CrossRef\]](#)
8. Ovca, A.; Jevšnik, M.; Raspor, P. Food safety awareness, knowledge and practices among students in Slovenia. *Food Control* **2014**, *42*, 144–151. [\[CrossRef\]](#)
9. Mirzaei, A.; Nourmoradi, H.; Zavareh, M.S.A.; Jalilian, M.; Mansourian, M.; Mazloomi, S.; Mokhtari, N.; Mokhtari, F. Food Safety Knowledge and Practices of Male Adolescents in West of Iran. *Open Access Maced. J. Med. Sci.* **2018**, *6*, 908–912. [\[CrossRef\]](#)
10. Ashkanani, F.; Husain, W.; Al Dwairji, M.A. Assessment of Food Safety and Food Handling Practice Knowledge among College of Basic Education Students, Kuwait. *J. Food Qual.* **2021**, *2021*, 5534034. [\[CrossRef\]](#)
11. Byrd-Bredbenner, C.; Maurer, J.; Wheatley, V.; Schaffner, D.; Bruhn, C.; Blalock, L. Food Safety Self-Reported Behaviors and Cognitions of Young Adults: Results of a National Study. *J. Food Prot.* **2007**, *70*, 1917–1926. [\[CrossRef\]](#)
12. Langiano, E.; Ferrara, M.; Lanni, L.; Viscardi, V.; Abbatecola, A.M.; De Vito, E. Food safety at home: Knowledge and practices of consumers. *J. Public Health* **2012**, *20*, 47–57. [\[CrossRef\]](#)
13. Eley, C.; Lundgren, P.; Kasza, G.; Truninger, M.; Brown, C.; Hugues, V.; Izsó, T.; Teixeira, P.; Syeda, R.; Ferré, N.; et al. Teaching young consumers in Europe: A multicentre qualitative needs assessment with educators on food hygiene and food safety. *Perspect. Public Health* **2021**, *142*, 175–183. [\[CrossRef\]](#)
14. Lavelle, F.; Spence, M.; Hollywood, L.; McGowan, L.; Surgenor, D.; McCloat, A.; Mooney, E.; Caraher, M.; Raats, M.; Dean, M. Learning cooking skills at different ages: A cross-sectional study. *Int. J. Behav. Nutr. Phys. Act.* **2016**, *13*, 119. [\[CrossRef\]](#)
15. Batista, S.; Stedefeldt, E.; Nakano, E.; Cortes, M.; Botelho, R.; Zandonadi, R.; Raposo, A.; Han, H.; Ginani, V. Design and Development of an Instrument on Knowledge of Food Safety, Practices, and Risk Perception Addressed to Children and Adolescents from Low-Income Families. *Sustainability* **2021**, *13*, 2324. [\[CrossRef\]](#)

16. Young, I.; Waddell, L.; Harding, S.; Greig, J.; Mascarenhas, M.; Sivaramalingam, B.; Pham, M.T.; Papadopoulos, A. A systematic review and meta-analysis of the effectiveness of food safety education interventions for consumers in developed countries. *BMC Public Health* **2015**, *15*, 822. [[CrossRef](#)]
17. Skivington, K.; Matthews, L.; Simpson, S.A.; Craig, P.; Baird, J.; Blazeby, J.M.; Boyd, K.A.; Craig, N.; French, D.P.; McIntosh, E.; et al. A new framework for developing and evaluating complex interventions: Update of Medical Research Council guidance. *BMJ* **2021**, *374*, n2061. [[CrossRef](#)]
18. Sivaramalingam, B.; Young, I.; Pham, M.T.; Waddell, L.; Greig, J.; Mascarenhas, M.; Papadopoulos, A. Scoping Review of Research on the Effectiveness of Food-Safety Education Interventions Directed at Consumers. *Foodborne Pathog. Dis.* **2015**, *12*, 561–570. [[CrossRef](#)]
19. Chapin, T.K.; Pfunter, R.C.; Stasiewicz, M.; Wiedmann, M.; Orta-Ramirez, A. Development and Evaluation of Food Safety Modules for K-12 Science Education. *J. Food Sci. Educ.* **2015**, *14*, 48–53. [[CrossRef](#)]
20. Shearer, A.E.; Snider, O.S.; Kniel, K.E. Development, Dissemination, and Preimplementation Evaluation of Food Safety Educational Materials for Secondary Education. *J. Food Sci. Educ.* **2013**, *12*, 28–37. [[CrossRef](#)]
21. Faccio, E.; Costa, N.; Losasso, C.; Cappa, V.; Mantovani, C.; Cibin, V.; Andrighetto, I.; Ricci, A. What programs work to promote health for children? Exploring beliefs on microorganisms and on food safety control behavior in primary schools. *Food Control* **2013**, *33*, 320–329. [[CrossRef](#)]
22. Cunha, D.; Fiorotti, R.; Baldasso, J.; Sousa, M.; Fontanezi, N.; Caivano, S.; Stedefeldt, E.; De Rosso, V.; Camatgo, M. Improvement of food safety in school kitchens during a long-term intervention period: A strategy based on the knowledge, attitude and practice triad. *Food Control* **2013**, *34*, 662–667. [[CrossRef](#)]
23. Peng, L.L.; Childress, A.; Dawson, J.; Jai, T.M.; Punyanunt-Carter, N.M.; Oldewage-Theron, W. Food Safety Education for Elementary School Students Worldwide. *Int. J. Sch. Health* **2021**, *8*, 3–13.
24. Warde, A. *The Practice of Eating*; Polity Press: Cambridge, UK, 2016.
25. Hann, M.; Hayes, C.V.; Lacroix-Hugues, V.; Lundgren, P.T.; McNulty, C.; Syeda, R.; Eley, C.; Teixeira, P.; Gennimata, D.; Truninger, M.; et al. Evidence-based health interventions for the educational sector: Application and lessons learned from developing European food hygiene and safety teaching resources. *Food Control* **2022**, *143*, 109219. [[CrossRef](#)]
26. *EpiData Entry*, version 4.4.1.0; A comprehensive tool for validated entry and documentation of data; The EpiData Association: Odense Denmark, 2019.
27. *Stata Statistical Software*, Release 16; StataCorp LLC: College Station, TX, USA, 2019.
28. Clarke, V.; Braun, V. Thematic analysis. *J. Posit. Psychol.* **2016**, *12*, 1–2.
29. Byrd-Bredbenner, C.; Abbot, J.M.; Wheatley, V.; Schaffner, D.; Bruhn, C.; Blalock, L. Risky Eating Behaviors of Young Adults—Implications for Food Safety Education. *J. Am. Diet. Assoc.* **2008**, *108*, 549–552. [[CrossRef](#)]
30. Beavers, A.S.; Murphy, L.; Richards, J.K. Investigating Change in Adolescent Self-Efficacy of Food Safety Through Educational Interventions. *J. Food Sci. Educ.* **2015**, *14*, 54–59. [[CrossRef](#)]
31. Barrett, T.; Feng, Y. Evaluation of food safety curriculum effectiveness: A longitudinal study of high-school-aged youths' knowledge retention, risk-perception, and perceived behavioral control. *Food Control* **2021**, *121*, 107587. [[CrossRef](#)]
32. Ovca, A.; Jevšnik, M.; Raspor, P. Challenges and strategies in the education of primary school children related to microbiological food safety—A review. *Sanit. Inženirstvo Int. J. Sanit. Eng. Res.* **2019**, *13*, 25. [[CrossRef](#)]
33. Kahoot! *Kahoot!* 2022. Available online: <https://kahoot.com/> (accessed on 4 August 2022).