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Food, nutrition and sustainability education in primary schools: a transnational analysis of teacher practices and perspectives across Australia, Sweden and the UK

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Food, nutrition and sustainability education in primary schools: a transnational analysis of teacher practices and perspectives across Australia, Sweden and the UK

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Abstract

Background: Food, nutrition and sustainability (FNS) education in primary school can promote healthy and sustainable dietary patterns. However, little is known about how FNS is taught in primary school classrooms beyond time-limited interventions. This transnational study addresses this gap by exploring current FNS education practices in primary schools in Australia, Sweden and the UK and analysing country-specific associations.

Methods: A cross-sectional online survey (Aug 2022-Nov 2024) collected data about: (i) FNS education practices (frequency, person who teaches, teaching approach, resources, information sources, family engagement); (ii) teacher perceptions (importance, school/teacher responsibilities); (iii) teacher attributes (understanding, confidence, knowledge/skills, enjoyment); and (iv) influencing factors (funding, professional development (PD), policies, infrastructure, barriers). Open-ended questions captured further teacher insights. Statistical analyses were conducted in STATA, including ordered and binary logistic regression to analyse country-specific associations. Qualitative data were analysed using content and thematic analysis.

Results: Respondents were 1246 teachers from Australia (33.2%), Sweden (33.6%) and the UK (33.2%). Only 29.3% reported FNS was taught frequently (≥once a fortnight). Teachers rated FNS education as equally important to most mandatory curriculum subjects and reported high levels of understanding, knowledge/skills, confidence and enjoyment regarding FNS education. A third or fewer had undertaken PD to teach this. FNS education was taught most frequently in Sweden, where teachers were most likely to have undertaken PD and have funding for FNS activities, to report no barriers to FNS education and to work at schools with food sustainability policies and cooking facilities (all $p<0.05$). Australian teachers were most likely to work in schools with food gardens and food waste management system (all $p<0.0005$). Thematic analysis generated five themes regarding the importance of FNS education; tensions in perceived responsibilities/priorities for FNS education; the need for sensitivity in FNS education; varying practices across schools; and influencing factors including curriculum, school space/infrastructure, school/teacher circumstances, time, funding, resources and support.

Conclusions: This transnational analysis provides novel insights regarding FNS education practices and teacher perspectives in Australia, Sweden and the UK. Findings can be used by school stakeholders, governments and researchers to understand and strengthen the position of FNS education in primary school settings.

Keywords

Food education, sustainability education, primary school, teacher, nutrition education, curriculum, school food

Background

Healthy dietary patterns from sustainable food systems are vital for population health and environmental preservation (1). However, globally, dietary patterns do not meet nutrition and planetary health recommendations (2). The primary school years (age 5-12 years) are an opportune time for building healthy and sustainable food behaviours, as potentially life-long food habits and ecological awareness begin to emerge (3, 4). One mechanism for supporting such food behaviours is through delivery of food, nutrition and sustainability (FNS) education in primary school. Whilst no formal definition of FNS education exists, it broadly includes teaching students about food skills (i.e., planning, purchasing, storing, preparing and cooking nutritious food), nutrition (i.e., nutritious foods and eating patterns that promote good health and reduce disease risk) and food sustainability (using nutritious food in ways that conserve natural resources and can continue into the future whilst minimising environmental harm) (5). Systematic reviews demonstrate that primary school interventions that include FNS education can improve children's nutrition knowledge (6, 7), dietary behaviours (6-11), and anthropometric outcomes (8, 11, 12). However, little is known about the actual delivery of FNS education at school, outside of time-limited and siloed interventions. One strategy for addressing this gap is by exploring and comparing approaches to FNS education in different countries.

Transnational perspectives

Transnational analyses offer a means to examine health-related issues across diverse policy, institutional, and environmental contexts and are most informative when countries differ in social, political and environmental contexts (13, 14). Australia, Sweden, and the United Kingdom (UK) provide a useful basis for examining primary school FNS pedagogy and practice. Whilst all are high-income Organisation for Economic Co-operation and Development (OECD) countries with mandatory schooling and government curricula, they differ in socio-political environments, educational philosophies, and school food policy frameworks (15). Australia (population of 26 million (16)) is a federation of independent States/Territories with broadly aligned education systems (17). The Australian Curriculum (implemented in most States/Territories), includes food and nutrition in the learning areas Health and Physical Education, Sciences and Design and Technologies (18). Sustainability is a cross-curriculum theme (19), though whether food sustainability is specifically included is unknown. In some States, localised curricula (based on the Australian Curriculum) include some food-related learning (20, 21). Sweden is a Nordic European nation (population of 10.5 million (22)) with a centrally legislated education system delivered via 290 municipalities (15). Schooling is universally free, including a mandated, tax-funded free school meals program for all students (23). Home Economics (HE) is a compulsory subject (24), which includes practical food skills and links between food

systems and planetary and public health (25). The UK is a Western European nation (population of 67 million (26)) encompassing England and the devolved regions of Scotland, Wales and Northern Ireland, which each have independent education systems (15). Food education is embedded in subjects related to Technology, Health Education, Science, Geography and Social Studies, with regional differences (27). These variations in national contexts, education systems and food curriculum frameworks suggest that delivery of primary school-based FNS education is likely to vary across Australia, Sweden, and the UK. However, this is currently unexplored.

Previous studies in transnational approaches to food at school

Only one previous study has compared primary school-based food practices across Australia, Sweden and the UK. This was an analysis of food provision policies, which did not consider food-related education, curricula or teaching practices (15). Three studies have investigated transnational approaches to school-based FNS education. Two of these analysed food (27) and nutrition-oral health (28) education within government curricula, though neither explored actual school-based delivery of FNS education. The third study assessed school food environments across five sub-Saharan African countries and considered food curricula, but relied on principal interviews and did not capture teacher perspectives or classroom-level delivery (29). To date, no studies have analysed transnational approaches to the delivery of FNS education in primary schools and from teachers' perspectives. As teachers are agents for FNS education, understanding their perspectives is essential. Addressing these research gaps is important for deciphering best-practice strategies for strengthening FNS education in primary school.

Aim

This study aimed to explore approaches to FNS education in primary schools in Australia, Sweden and the UK, including FNS education practices, teacher perceptions and attributes, and influencing factors. The secondary aim was to analyse whether teaching frequency and influencing factors were associated with country.

Methods

Ethics approval and consent to participate:

Ethical approval for this study was obtained from the Deakin University Human Ethics Advisory Group (HEAG-H 127_2022, and all respondents provided voluntary and informed consent to participate

Study design, setting and participants

A cross-sectional online survey with closed and open-ended questions collected data from primary school teachers (typically teachers of children aged 5-12 years). Eligible participants were classroom teachers at a registered school in Australia, Sweden or the UK. Using the STATA sample size calculator (30), a sample of 388 respondents per country was calculated to detect a 10% difference in country-specific responses with 80% power, consistent with contemporary research (31). The target sample size was therefore 388 participants per country (n= 1164).

Recruitment

Respondents were recruited in Australia (August 2022-October 2023), Sweden (February 2023-July 2025) and the UK (November 2022-September 2024) via convenience sampling using country-specific advertisements with an online survey link. Recruitment occurred via: (i) paid and unpaid social media campaigns; (ii) mailing lists and websites of education- and nutrition-sector organisations; (iii) directly to schools using listings from government departments (all countries) and Catholic diocese (Australia only); and (iv) alumni listings from teacher education courses at Deakin University (Australia), Gothenburg University (Sweden) and Queen's University Belfast (UK). Third party consent was obtained from organisations prior to circulating the recruitment advertisement. Participants who received the advertisement and clicked on the embedded link were directed to a voluntary, self-administered survey. After selecting their country ('Australia', 'Sweden' or 'United Kingdom'), participants were re-directed to a country-specific survey with a linked Plain Language Statement (adapted to country-specific contexts) and embedded consent. Participants who consented to participate and who responded 'yes' to the screening question *'Are you currently a classroom teacher of primary level students (Foundation - Grade 6) at a school in [Australia/Sweden/the United Kingdom?]*' could complete the survey. Recruitment continued in each country until the target sample size was met, at which stage the country-specific survey was closed. Participants who completed the survey could opt-in to a draw to win one of five vouchers per country to the value of AUD50/SEK350/GBP30.

Survey instrument

A survey tool was purpose-designed in English, and for the Australian context, based on published tools that have assessed school-based food sustainability (32) and nutrition (33, 34) practices. The survey collected data about: (i) FNS education practices (frequency, person who teaches, teaching approach, resources, information sources, family engagement); (ii) teacher perceptions (importance, school/teacher responsibilities); (iii) teacher attributes (understanding, confidence, PD, knowledge/skills, enjoyment); (iv) influencing factors (funding, professional

development, policies, infrastructure, barriers); and (v) school and teacher demographics (see Table 1 for survey summary and Appendix 1 for complete survey).

Table 1: Summary of survey sections, example questions/topics and response types

Survey section	Example questions/topics	Response types
Section 1: FNS education practices (n=11 questions)	• How frequently are students taught about FNS? • Who teaches FNS? • Is FNS taught as a stand-alone/cross-curricular subject • What resources/materials do you use to teach FNS? • Where do you obtain FNS teaching resources? • How are families engaged in FNS education?	Single-select/multi-select
Section 2: Teacher perceptions regarding FNS education (n=21 questions)	• How important is it to teach primary school students about FNS?	5-point Likert scale (extremely important – not at all important)
	• How important is FNS education compared to other subjects?	3-point Likert scale (FNS is more important/as important/less important)

	• Primary schools should:
	  ○ Teach FNS in the curriculum
	  ○ Have policies in place about food and nutrition
	  ○ Have a food garden/food waste system /cooking facilities that can be used for teaching
	  ○ Monitor daily food waste
	• Primary school teachers should
	  ○ Role model healthy eating
	  ○ Encourage students to eat healthy food
		5-point Likert scale (strongly agree – strongly disagree)

Section 3: Teacher attributes regarding FNS education (n=12 questions)	• I understand/am confident/have knowledge and skills/enjoy teaching students about FNS education	5-point Likert scale (strongly agree – strongly disagree)
Section 4: Factors influencing FNS education (n=21 questions)	• I have undertaken training/ professional development to teach students about FNS education	5-point Likert scale (strongly agree – strongly disagree)
	• Do you have access to funding for FNS activities/professional development?	Single-select/multi-select

	• Does your school have written policies about:
	  ○ Teaching FNS in the curriculum
	  ○ Food sustainability
	• Does your school have a food garden /food waste management system/ cooking facilities that can be used for teaching purposes?
	• Which challenges do you experience about teaching FNS?	

Section 5: School and teacher demographics
 	
(n=10 questions)
	• School characteristics:
	  ○ State, postcode, school type, number of enrolments
	• Teacher characteristics:
	  ○ Grades taught, years of teaching experience, years in current role, postcode, age, gender identity
		Single-select/multi-select

Quantitative response options included matrices with 3- and 5-point Likert scales, single-select and multi-select, with follow up prompts to elicit specific details (e.g., '*please specify…*'). Three open-ended questions were included to capture additional insights deemed important by respondents (e.g., *'Is there anything else you think is important for us to know about…?'*). The survey was tested for face validity by six researchers with expertise in school-based FNS education, including two teachers, with minor amendments made to improve clarity. The survey was built into the secure REDCap (Research Electronic Data Capture) platform (50) and was designed to be completed in approximately 15 minutes. Copies of the survey were generated in REDCap for data collection in Sweden and the UK, which included minor country-specific adaptations (e.g., references to national dietary guidelines, curricula and health/education departments). The English survey was translated to Swedish by one Swedish author (FT) using the REDCap Multi-Language Management module, and this translation was checked by a second Swedish author (CL) for accuracy of phrasing. Translations were tested by three home economics teachers with experience in Swedish school sector who worked at the University of Gothenburg.

Data analysis

Statistical analysis

Statistical analyses were conducted using STATA, including descriptive statistics for all variables. Sample characteristics were presented as frequencies and percentages. Frequencies and percentages for the complete cohort of teachers as well as subgroups by country were reported for FNS education practices, teacher perceptions and attributes and influencing factors.

For the transnational analysis, associations between country and frequency of FNS education, teacher PD, access to funding, school-level policies, presence of infrastructure and reported barriers were analysed using logistic regression models adjusted for school type and size. School type was dichotomised as 'Government' vs 'Non-government' (including independent/private and other schools). School size was grouped into three categories based on student enrolments (0-299, 300-599, ≥600). There was no evidence of multicollinearity between school characteristics. Associations were reported as odds ratios (ORs) with 95%CI. Statistical significance was set at $p<0.05$

Associations between country and frequency of FNS education and teacher PD were analysed using ordered logistic regression. The eight option question about frequency of FNS education was categorised as 'never' vs 'infrequently' (once or twice a term/once or twice a year/<once a year) vs 'frequently' (>once a week/once a week/once a fortnight). Qualitative responses to the prompt question about frequency of FNS education were read and categorised as never/infrequently/frequently where possible. The five-point Likert scale question about whether teachers had undertaken professional development to teach FNS was grouped into three categories ('strongly disagree/disagree' vs 'neither agree nor disagree' vs 'agree/strongly agree').

Four category questions about presence of school infrastructure that could be used for teaching ('no'/'unsure'/'yes, but not used for teaching'/'yes, and used for teaching') and three category questions about the presence of FNS policies ('no'/'unsure'/'yes') were dichotomised ('no' vs 'yes'). Country-specific associations with these variables, as well as access to funding and barriers to FNS education were analysed using binary logistic regression.

Content and thematic analysis

Quantitative content analysis was used to analyse responses to prompt questions (e.g., *'please specify…'*) in Excel. Responses were read by the lead author (JVK), who developed a preliminary coding framework based on question topics and frequent responses. JVK and AOB individually coded a 10% sample of responses using the preliminary framework. Codes were discussed and refined until consensus was reached. JVK then deductively coded responses to all prompt questions.

Braune and Clarke's approach to inductive thematic analysis was used to explore the three open-ended questions that captured information deemed important by respondents. JVK and AOB independently analysed a 10% sample of open-ended responses (n=126) using an open coding technique. Codes were discussed until consensus was reached. JVK then coded the full sample of open-ended responses. Codes were systematically categorized to determine common themes. Through iterative analysis and discussion with the full research team, themes were refined and named

and then rechecked to ensure they accurately reflected raw data extracts. This verification process has been previously used in inductive thematic analysis of qualitative survey research in food education (35).

Results

Respondents

In total, 1246 primary school teachers completed the survey (Figure 1) across Australia (33.2%), Sweden (33.6%) and the UK (33.2%) (Table 2). Teachers were mostly female (89.2%) with 1-5 (19.3%) or 6-10 (21.8%) years of experience and mostly worked in government schools (81.6%). All primary year levels were represented.

Figure 1: Participant recruitment and survey responses

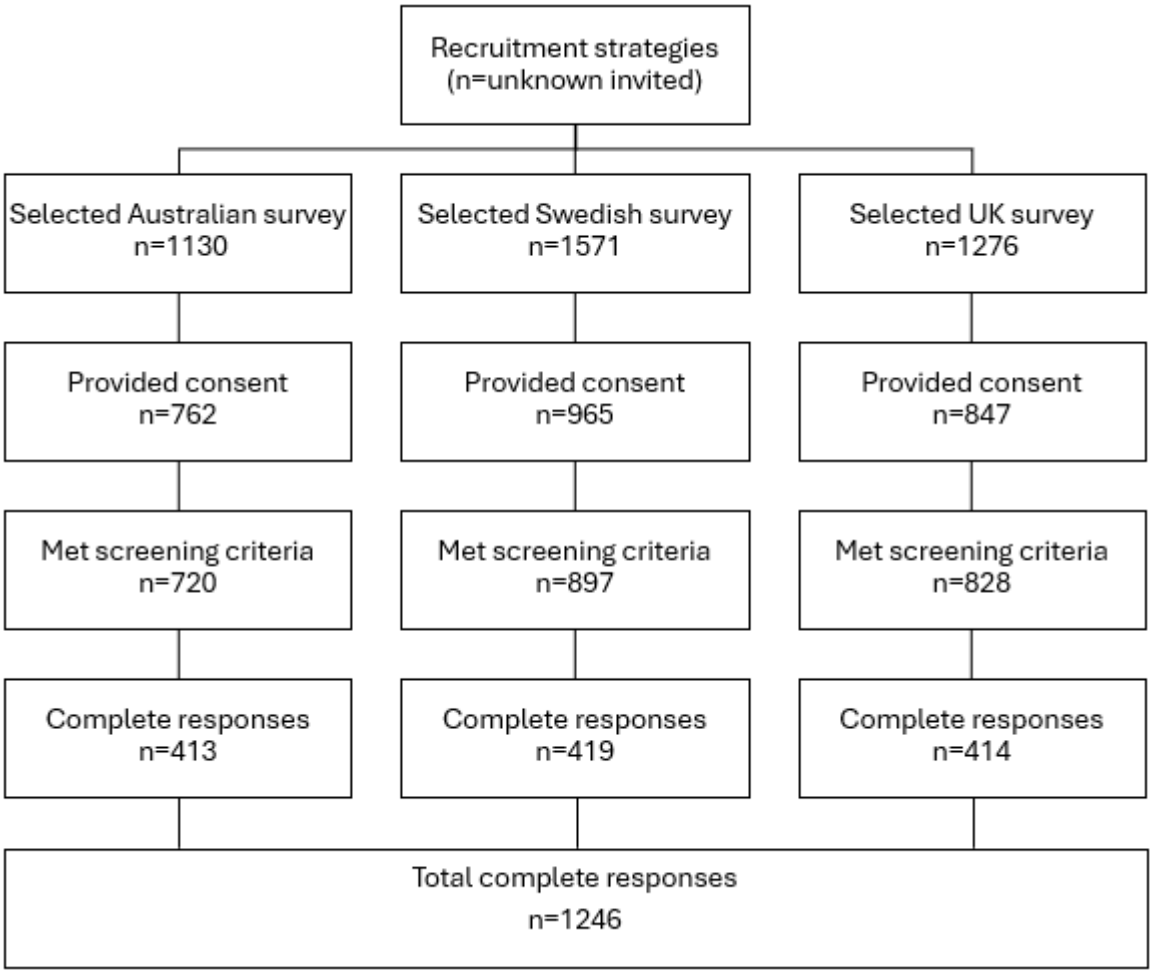


Table 2: School and teacher characteristics (n=1246)

	n	%
Country		
Australia	413	33.2
Sweden	419	33.6
United Kingdom	414	33.2
School characteristics		
School type		
Government/public	1017	81.6
Non-government*	229	18.4
Student enrolments		
≤299	598	48.0
300-499	390	31.3
≥500	258	20.7
Teacher characteristics		
Grades taught#		
Foundation	250	20.0
Grade 1	314	25.2
Grade 2	359	28.9
Grade 3	378	30.3
Grade 4	412	33.1
Grade 5	370	29.7
Grade 6	387	31.1
Time as a teacher (years)		
<1	51	4.1
1-5	240	19.3
6-10	271	21.7
11-15	191	15.3
16-20	149	12.0
21-25	137	11.0
>25	207	16.6
Time in current role (years)		
<1	180	14.4
1-5	485	38.9
6-10	274	22.0
11-15	109	8.7
16-20	73	5.9
21-25	48	3.9
>25	77	6.2
Gender		
Female	1112	89.2
Male	103	8.3
Other	31	2.5
Age (years)		
18–24	35	2.8
25-34	290	23.3

35-44	339	27.2
45-54	325	26.1
55-64	246	19.7
>65	11	0.9

* Includes Independent/private (n=143), Catholic (Australia only, n=77) and other school types (n=9)
# For 'grades taught' percentages do not sum to 100% due to respondents teaching in more than one grade level

Quantitative results

FNS education practices

Frequency of FNS education

Less than a third of teachers (29.3%) reported FNS was taught frequently (>once a week/once a week/once a fortnight) (Table 3) and frequency was significantly higher in Sweden than Australia ($p=0.012$) or the UK ($p<0.0005$). Only 29.5% of teachers stated enough time is spent teaching FNS.

Person who teaches FNS education

While 41.5% of teachers reported they alone teach FNS to their students (Table 3), the rest reported others teach this, e.g., a Health/Physical Education (HPE) (n=169), Home Economics (HE) (n=115), STEM (Science, Technology, Engineering and Mathematics) (n=51), kitchen/garden (n=37) or other (n=59) specialist teacher, a general teacher (n=163) or teaching/classroom assistant (n=75). Of 150 teachers who did not teach FNS themselves, (72.7%) were interested to do this in the future.

Teaching approach and cross-curricular integration

Most teachers who taught FNS used a cross-curriculum approach (84.4%), and FNS was mostly integrated into Sciences (74.2%) and HPE (70.5%) (Table 3).

Resources, activities and information sources

Videos (78.9%), real food/food labels (72.4%) and PowerPoint slides (69.0%) were common resources used for FNS education (Table 3). Teachers sourced materials from teacher-specific websites (62.4%), curriculum documents (49.7%) and other teachers (44.9%). More teachers created their own resources (47.5%) than using information from government departments (44.1%) or experts (8.4%). When prompted, 688 teachers described how they determine the credibility of these information sources. They stated relying on their own research/professional judgement (n=359) or using sources they deem trustworthy (n=248).

Family engagement

Teachers most commonly engaged families in FNS activities via newsletters (46.1%) and sending resources home (22.7%) (Table 3).

Table 3: FNS teaching practices including frequency, teaching approach, resources and activities, information sources and family engagement strategies, according to country

	AU n (%)	SW n (%)	UK n (%)	Total n (%)
Frequency of FNS education				
How frequently are students in your class taught about FNS? (n=1246)				
Frequently[i]	128 (31.0)	154 (36.8)	83 (20.0)	365 (29.3)
Infrequently[ii]	224 (54.2)	227 (54.2)	315 (76.1)	766 (61.5)
Never[iii]	53 (12.8)	28 (6.7)	13 (3.1)	94 (7.5)
Other	8 (1.9)	10 (2.4)	3 (0.7)	21 (1.7)
Do you think enough time is spent teaching your students about FNS? (n=1246)				
Yes	107 (25.9)	161 (38.4)	99 (23.9)	367 (29.5)
No	306 (74.1)	258 (61.6)	315 (76.1)	879 (70.6)
Person who teaches FNS				
Who usually teaches FNS to students in your class? (n=1154[iv])				
Only me	146 (40.4)	118 (30.1)	214 (53.4)	478 (41.4)
Me and others	183 (50.7)	243 (61.8)	181 (45.1)	607 (52.6)
Only others	32 (8.9)	31 (7.9)	6 (1.5)	69 (6.0)
Would you be interested in teaching FNS in the future? (n=150[v])				
Yes	64 (85.3)	29 (51.8)	16 (84.2)	109 (72.7)
No	11 (14.7)	27 (48.2)	3 (15.8)	41 (27.3)
FNS teaching approach				
Do you teach FNS as (n=1085[vi]):				
Stand-alone subject only	70 (21.3)	46 (12.7)	53 (13.4)	169 (15.6)
Cross-curriculum subject[vii]	259 (78.7)	315 (87.3)	342 (86.6)	916 (84.4)
Using a cross-curriculum approach, in which subjects do you currently teach FNS? (n=916)				
Sciences	141 (54.4)	271 (86.0)	268 (78.4)	680 (74.2)
Health and Physical Education	215 (83.0)	189 (60.0)	242 (70.8)	646 (70.5)
Humanities and Social Sciences	107 (41.3)	157 (49.8)	105 (30.7)	369 (40.3)
Literacy	131 (50.6)	98 (31.1)	133 (38.9)	362 (39.5)
Mathematics	65 (25.1)	50 (15.9)	89 (26.0)	204 (22.3)
Technologies	45 (17.4)	36 (11.4)	83 (24.3)	164 (17.9)
Languages	23 (8.8)	35 (11.1)	35 (10.2)	93 (10.2)
The arts	19 (7.3)	39 (12.4)	27 (7.9)	85 (9.3)
What sort of resources, materials and activities do you use to teach FNS? *(n=1085[vi])*				
Videos	260 (79.0)	283 (78.4)	313 (79.2)	856 (78.9)
Real food/food labels	231 (70.2)	225 (62.3)	329 (83.3)	785 (72.4)
PowerPoint slides	212 (64.4)	199 (55.1)	338 (85.5)	749 (69.0)
Websites	211 (64.1)	215 (59.6)	239 (60.5)	665 (61.3)
Cooking and/or food preparation	162 (49.2)	130 (36.0)	290 (73.4)	582 (53.6)
Discussions	157 (47.7)	237 (65.7)	181 (45.8)	575 (53.0)
Food tasting	136 (41.3)	134 (37.1)	302 (76.5)	572 (52.7)
Diagrams/posters	218 (66.3)	91 (25.2)	240 (60.8)	549 (50.6)
Books	145 (44.1)	217 (60.1)	155 (39.2)	517 (47.6)
Food label reading/exploration	140 (42.6)	121 (33.5)	197 (49.9)	458 (42.2)

Food models or photos	137 (41.6)	89 (24.7)	193 (48.9)	419 (38.6)
Quizzes	68 (20.7)	146 (40.4)	120 (30.4)	334 (30.8)
Composting	138 (41.9)	96 (26.6)	77 (19.5)	311 (28.7)
Excursions (trips outside of school)	82 (24.9)	83 (23.0)	97 (24.6)	262 (24.1)
Games	84 (25.5)	50 (13.9)	117 (29.6)	251 (23.1)
Incursions (visitors to school)	93 (28.3)	26 (7.2)	97 (24.6)	216 (19.9)
Garden tours	90 (27.4)	26 (7.2)	67 (17.0)	183 (16.9)
Magazines	57 (17.3)	45 (12.5)	50 (12.1)	152 (14.0)
Where do you obtain educational resources for teaching FNS? (n=1085[vi])				
Websites dedicated to teaching resources	195 (59.3)	220 (60.9)	262 (66.3)	677 (62.4)
Curriculum documents	164 (49.8)	216 (59.8)	159 (40.3)	539 (49.7)
I create my own resources	145 (44.1)	146 (40.4)	224 (56.7)	515 (47.5)
Other teachers	148 (45.0)	196 (54.3)	143 (36.2)	487 (44.9)
Government health departments	110 (33.4)	210 (58.2)	159 (40.3)	479 (44.1)
YouTube	163 (49.5)	64 (17.7)	168 (42.5)	395 (36.4)
General websites	125 (38.0)	102 (28.3)	142 (35.9)	369 (34.0)
Social media	46 (14.0)	90 (24.9)	52 (13.2)	188 (17.3)
External experts	41 (12.5)	25 (6.9)	38 (9.6)	104 (8.4)
Which strategies are used to engage families in your school's FNS activities? (n=1246)				
Newsletters	207 (50.1)	146 (34.8)	221 (53.4)	574 (46.1)
Sending resources home (e.g., recipes)	104 (25.2)	55 (13.1)	124 (30.0)	283 (22.7)
Emails	88 (21.3)	71 (17.0)	107 (25.9)	266 (21.3)
App messages	68 (16.5)	40 (9.6)	99 (23.9)	207 (16.6)
Family participation in gardening, composting and cooking activities	81 (19.6)	16 (3.8)	68 (16.4)	165 (13.2)
Family participation in classroom activities	62 (15.0)	16 (3.8)	69 (16.7)	147 (11.8)
Meetings and information sessions	38 (9.2)	53 (12.7)	45 (10.9)	136 (10.9)

AU=Australia, SW=Sweden, UK=United Kingdom

[i]Respondents who specified FNS is taught 'a few times a week' (n=86), 'once a week' (n=165), 'once a fortnight' (n=104), or who specified an open-ended response that could be classified in these categories (n=10)

[ii]Respondents who specified FNS is taught 'once or twice a term' (n=413), 'once or twice a year' (n=347) or who specified an open-ended response that could be classified in these categories (n=6)

[iii]Respondents who specified FNS is taught 'never but I am interested in this being taught to my students' (n=81), 'never and I am not interested in this being taught to my students' (n=11) or who specified an open-ended response that could be classified as 'never' (n=2)

[iv]Respondents who specified FNS is taught 'a few times a week' (n=86), 'once a week' (n=165), 'once a fortnight' (n=104), 'once or twice a term' (n=413), 'once or twice a year' (n=347), 'other' (n=39)

[v]Respondents who specified FNS is never taught 'never but I am interested in this being taught to my students' (n=81) and who specified that 'only others' teach FNS to their students (n=69)

[vi]Respondents who specified they teach FNS themselves either solely (n=478) or together with others (n=607)

[vii]Includes 'cross-curriculum subject only' (n=388) and 'both stand-alone and cross-curriculum subjects' (n=528)

Teacher perceptions regarding FNS education

Importance of FNS education

Teachers considered it very/extremely important to teach nutrition (85.7%), food sustainability (75.2%) and food skills (70.1%) (Table 4). Whilst 46.1% stated these topics are equally important, 39.7% reported nutrition is the most important part of FNS education. Most teachers considered FNS education to be as important other curriculum subjects except Literacy and Mathematics.

Table 4: Teacher perceptions about importance of FNS education and the role of schools and teachers in FNS education, according to country (n=1246)

	AU n (%)	SW n (%)	UK n (%)	Total n (%)
How important is it to teach students about:				
Nutrition				
Extremely/very important	346 (83.8)	335 (80.0)	387 (93.5)	1068 (85.7)
Moderately important	52 (12.6)	62 (14.8)	19 (4.6)	133 (10.7)
Slightly/not at all important	15 (3.63)	22 (5.3)	8 (1.9)	45 (3.9)
Food skills				
Extremely/very important	288 (69.7)	267 (63.7)	319 (77.1)	874 (70.1)
Moderately important	80 (19.4)	104 (24.8)	64 (15.5)	248 (19.9)
Slightly/not at all important	45 (10.9)	48 (11.5)	31 (7.5)	124 (10.0)
Food sustainability				
Extremely/very important	306 (74.1)	305 (72.8)	326 (78.7)	937 (75.2)
Moderately important	73 (17.7)	91 (21.7)	67 (16.2)	231 (18.5)
Slightly/not at all important	34 (8.2)	23 (5.5)	21 (5.1)	78 (6.3)
What is the most important part of FNS education for primary school students?				
Nutrition	143 (34.6)	168 (40.1)	183 (44.2)	494 (39.6)
Food skills	24 (5.8)	44 (10.5)	42 (10.1)	110 (8.8)
Food sustainability	22 (5.3)	541 (9.8)	5 (1.2)	68 (5.5)
All of these are equally important	224 (54.2)	166 (39.6)	184 (44.4)	574 (46.1)
How important is FNS education for primary school students compared to these other subjects/learning areas:				
Literacy (including language, literature and literacy)				
FNS is more important	8 (1.9)	9 (2.2)	10 (2.4)	27 (2.2)
FNS is as important	184 (44.6)	190 (45.4)	195 (47.1)	569 (45.7)
FNS is less important	221 (53.5)	220 (52.5)	209 (52.3)	650 (52.2)
Mathematics				
FNS is more important	12 (2.9)	12 (2.9)	8 (1.9)	2 (2.6)
FNS is as important	182 (44.1)	214 (51.1)	200 (48.3)	596 (47.8)
FNS is less important	219 (53.0)	193 (46.1)	206 (49.8)	618 (49.6)
Science				
FNS is more important	23 (5.6)	21 (5.0)	18 (4.4)	62 (5.0)
FNS is as important	293 (70.9)	343 (81.9)	317 (76.6)	953 (76.5)

FNS is less important	97 (23.5)	55 (13.1)	79 (19.1)	231 (18.5)
Health and Physical Education				
FNS is more important	23 (5.6)	17 (4.1)	17 (4.1)	57 (4.6)
FNS is as important	359 (86.9)	370 (88.3)	373 (90.1)	1102 (88.4)
FNS is less important	31 (7.5)	32 (7.6)	24 (5.8)	87 (7.0)
Humanities and Social Sciences				
FNS is more important	49 (11.9)	21 (5.0)	67 (16.2)	137 (11.0)
FNS is as important	298 (72.2)	303 (72.3)	310 (74.9)	911 (73.1)
FNS is less important	66 (16.0)	95 (22.7)	37 (8.9)	198 (15.9)
The Arts (including dance, drama, art, music)				
FNS is more important	59 (14.3)	84 (20.1)	94 (22.7)	237 (19.0)
FNS is as important	289 (70.0)	262 (62.5)	274 (66.2)	825 (66.2)
FNS is less important	65 (15.7)	73 (17.4)	46 (11.1)	184 (14.8)
Technologies				
FNS is more important	52 (12.6)	80 (19.1)	55 (13.3)	187 (15.0)
FNS is as important	280 (67.8)	271 (64.7)	306 (73.9)	857 (68.8)
FNS is less important	81 (19.6)	68 (16.2)	53 (12.8)	202 (16.2)
Languages				
FNS is more important	128 (31.0)	31 (7.4)	105 (25.4)	264 (21.2)
FNS is as important	208 (50.4)	226 (53.9)	262 (63.3)	696 (55.9)
FNS is less important	77 (18.6)	162 (38.7)	47 (11.4)	286 (23.0)
Mental Health/Wellbeing				
FNS is more important	18 (4.4)	27 (6.4)	14 (3.4)	59 (4.7)
FNS is as important	305 (73.9)	355 (84.7)	337 (81.4)	997 (80.0)
FNS is less important	90 (21.8)	37 (8.8)	63 (15.2)	190 (15.3)
Primary schools should:				
Teach FNS as part of the curriculum				
Strongly agree/agree	355 (86.0)	351 (83.8)	394 (95.2)	1100 (88.3)
Neither agree nor disagree	35 (8.5)	54 (12.9)	15 (3.6)	104 (8.4)
Disagree/strongly disagree	23 (5.6)	14 (3.3)	5 (1.2)	42 (3.4)
Have policies in place about FNS				
Strongly agree/agree	287 (69.5)	337 (80.4)	355 (85.8)	979 (78.6)
Neither agree nor disagree	78 (18.9)	72 (17.2)	51 (12.3)	201 (16.1)
Disagree/strongly disagree	48 (11.6)	10 (2.4)	8 (1.9)	66 (5.3)
Have a kitchen/cooking facilities that can be used for teaching purposes				
Strongly agree/agree	349 (84.5)	368 (87.8)	383 (92.5)	1100 (88.3)
Neither agree nor disagree	43 (10.4)	43 (10.3)	25 (6.0)	111 (8.9)
Disagree/strongly disagree	21 (5.1)	8 (1.9)	6 (1.5)	35 (2.8)
Have a food waste system (e.g., compost) that can be used for teaching purposes				
Strongly agree/agree	360 (87.2)	365 (87.1)	347 (83.8)	1072 (86.0)
Neither agree nor disagree	41 (9.9)	44 (10.5)	57 (13.8)	142 (11.4)
Disagree/strongly disagree	12 (2.9)	10 (2.4)	10 (2.4)	32 (2.6
Have a food garden that can be used for teaching purposes				
Strongly agree/agree	340 (82.3)	237 (56.6)	328 (79.2)	905 (72.6)
Neither agree nor disagree	56 (13.6)	133 (31.7)	70 (16.9)	259 (20.8)
Disagree/strongly disagree	17 (4.1)	49 (11.7)	16 (3.9)	82 (6.6)

Monitor the amount of food they waste daily (e.g., from canteens, lunchboxes, staffrooms)				
Strongly agree/agree	268 (64.9)	326 (77.8)	278 (67.2)	872 (70.0)
Neither agree nor disagree	79 (19.1)	72 (17.2)	104 (29.4)	255 (20.5)
Disagree/strongly disagree	66 (16.0)	21 (5.0)	32 (7.7)	119 (9.6)
Primary school teachers should:				
Role model healthy eating to students				
Strongly agree/agree	331 (80.2)	367 (87.6)	350 (84.5)	1048 (84.1)
Neither agree nor disagree	49 (11.9)	47 (11.2)	48 (11.6)	144 (11.6)
Disagree/strongly disagree	33 (8.0)	5 (1.2)	16 (3.9)	54 (4.3)
Encourage students to eat healthy food				
Strongly agree/agree	367 (88.9)	396 (94.5)	399 (96.4)	1162 (93.3)
Neither agree nor disagree	33 (8.0)	17 (4.1)	10 (2.4)	60 (4.8)
Disagree/strongly disagree	13 (3.2)	6 (1.4)	5 (1.2)	24 (1.9)

AU=Australia, SW=Sweden, UK=United Kingdom

School and teacher responsibilities

Most teachers agreed FNS education should be taught in the curriculum (88.3%); that schools should have FNS policies (78.6%); that cooking facilities (88.3%), food waste management systems (86.0%) and food gardens (72.6%) should be available for teaching; and that schools should monitor their food waste (70.0%) (Table 4). Teachers further agreed they should encourage students to eat healthy food (93.3%) and role model healthy eating (84.1%).

Teacher perceptions regarding FNS education

Teachers reported higher levels of understanding, knowledge/skills, confidence and enjoyment regarding nutrition and food skills education, with lower levels reported for food sustainability education (Table 5).

Table 5: Teacher attributes (understanding, knowledge/skills, confidence, enjoyment) regarding FNS education, according to country (n=1246)

	AU n (%)	**SW n (%)**	**UK n (%)**	**Total n (%)**
I have a good understanding of:				
Nutrition				
Strongly agree/agree	382 (92.5)	380 (90.7)	389 (94.0)	1151 (92.4)
Neither agree nor disagree	18 (4.4)	31 (7.4)	18 (4.4)	67 (5.4)
Disagree/strongly disagree	13 (3.2)	8 (1.9)	7 (1.7)	28 (2.3)
Food skills				
Strongly agree/agree	369 (89.4)	374 (89.3)	371 (89.6)	1114 (89.4)
Neither agree nor disagree	33 (8.0)	39 (9.3)	33 (8.0)	105 (8.4)
Disagree/strongly disagree	11 (2.7)	6 (1.4)	10 (2.4)	27 (2.2)
Food sustainability				
Strongly agree/agree	325 (78.7)	358 (85.4)	305 (73.7)	988 (79.3)

Neither agree nor disagree	60 (14.5)	52 (12.4)	75 (18.1)	187 (15.0)
Disagree/strongly disagree	28 (6.8)	9 (2.2)	34 (8.2)	71 (5.7)
I have the knowledge and skills required to teach my students about:				
Nutrition				
Strongly agree/agree	312 (75.5)	303 (72.3)	350 (84.5)	965 (77.5)
Neither agree nor disagree	53 (12.8)	68 (16.2)	36 (8.7)	157 (12.6)
Disagree/strongly disagree	48 (11.6)	48 (11.5)	28 (6.8)	124 (10.0)
Food skills				
Strongly agree/agree	291 (70.5)	274 (73.7)	312 (75.4)	877 (73.1)
Neither agree nor disagree	68 (16.5)	82 (22.0)	54 (13.0)	204 (17.0)
Disagree/strongly disagree	54 (13.1)	16 (4.3)	48 (11.6)	118 (9.8)
Food sustainability				
Strongly agree/agree	258 (62.5)	283 (67.5)	250 (60.4)	791 (63.5)
Neither agree nor disagree	88 (21.3)	83 (19.8)	90 (21.7)	261 (21.0)
Disagree/strongly disagree	67 (16.2)	53 (12.7)	74 (17.9)	194 (15.6)
I am confident in my ability to teach my students about:				
Nutrition				
Strongly agree/agree	358 (86.7)	351 (83.8)	375 (90.6)	1084 (87.0)
Neither agree nor disagree	26 (6.3)	47 (11.2)	21 (5.1)	94 (7.5)
Disagree/strongly disagree	29 (7.0)	21 (5.0)	18 (4.4)	68 (5.5)
Food skills				
Strongly agree/agree	340 (82.3)	327 (78.0)	333 (80.4)	1000 (80.3)
Neither agree nor disagree	47 (11.4)	66 (15.8)	45 (10.9)	158 (12.7)
Disagree/strongly disagree	26 (6.3)	26 (6.2)	36 (8.7)	88 (7.1)
Food sustainability				
Strongly agree/agree	305 (73.9)	321 (76.6)	276 (66.7)	902 (72.4)
Neither agree nor disagree	64 (15.5)	70 (16.7)	83 (20.1)	217 (17.4)
Disagree/strongly disagree	44 (10.7)	28 (6.7)	55 (13.3)	127 (10.2)
I enjoy/would enjoy teaching my students about:				
Nutrition				
Strongly agree/agree	352 (85.2)	356 (85.0)	378 (91.3)	1086 (87.2)
Neither agree nor disagree	34 (8.2)	52 (12.4)	29 (7.0)	115 (9.2)
Disagree/strongly disagree	27 (6.5)	11 (2.6)	7 (1.7)	45 (3.6)
Food skills				
Strongly agree/agree	339 (82.1)	334 (79.7)	368 (88.9)	1041 (83.6)
Neither agree nor disagree	41 (9.9)	66 (15.8)	34 (8.2)	141 (11.3)
Disagree/strongly disagree	339 (82.1)	334 (79.7)	368 (88.9)	64 (5.1)
Food sustainability				
Strongly agree/agree	324 (78.5)	339 (80.9)	342 (82.6)	1005 (80.7)
Neither agree nor disagree	58 (14.0)	66 (15.8)	62 (15.0)	186 (14.9)
Disagree/strongly disagree	31 (7.5)	14 (3.3)	10 (2.4)	55 (4.4)

AU=Australia, SW=Sweden, UK=United Kingdom

Factors influencing FNS education

Funding

Only 29.3% of teachers had funding for FNS activities (29.3%) and 16.5% had funding for PD about teaching FNS to students (Table 6). Funding for FNS activities was more likely in Sweden than the UK ($p=0.01$) and Australia ($p=0.029$), and funding for PD was more likely in Sweden ($p=0.002$) and Australia ($p=0.015$) than the UK. Most teachers (89.9%) stated they would participate in PD if it were funded.

Professional development

A third of teachers (34.6%) had undertaken (PD) to teach nutrition and fewer had undertaken PD to teach food sustainability (28.4%) or food skills (24.6%) (Table 6). Swedish teachers were most likely to have undertaken PD across all three domains of FNS education (all $p<0.01$).

Policies

Only 43% of schools had policies about teaching FNS in the curriculum 25.0% had policies and about food sustainability (e.g., managing food waste) (Table 6). Food sustainability policies were most likely in Swedish schools, whilst curriculum policies were least likely in Australian schools (all $p<0.0005$).

Presence and use of infrastructure

Most schools (57.5%) had kitchens/cooking facilities, and fewer had food gardens (46.9%) and food waste management systems (37.1%) available for teaching purposes (Table 6). Gardens and food waste management systems were most likely in Australian schools (all $p<0.0005$). Cooking facilities were more likely in Swedish than Australian ($p=0.031$) or UK ($p<0.0005$) schools. When present, more than half of teachers reported that cooking facilities (65.9%) food waste management systems (59.7%) and food gardens (53.3%), were used for teaching.

Barriers

Common barriers to FNS education included inadequate funding (52.4%) and inadequate resources and materials (44.1%) (Table 6). These barriers were more likely in Australia and the UK than Sweden (all $p<0.05$). Only 12.4% of teachers reported not experiencing any barriers to teaching FNS, and these teachers were more likely to be from Sweden than Australia ($p=0.001$) or the UK ($p<0.0005$).

Table 6: Factors influencing FNS education factors (funding, professional development, policies, infrastructure and barriers), according to country and with country-specific associations (n=1246)

	AU n (%)	SW n (%)	UK n (%)	OR	95%CI	p-value	Total n (%)
Funding for FNS activities and professional development							
Funding for FNS activities							
Yes	123 (29.8)	147 (35.1)	95 (23.0)	SW v AU=1.41 UK v AU=0.84 SW v UK=1.69	SW v AU=1.04, 1.92 UK v AU=0.60, 1.18 SW v UK=1.24, 2.30	**SW v AU=0.029** UK v AU=0.304 **SW v UK=0.001**	365 (29.3)
No	290 (70.2)	272 (64.9)	319 (77.1)				881 (70.7)
Funding for PD about teaching FNS to students							
Yes	82 (19.9)	81 (19.3)	42 (10.1)	SW v AU=1.12 AU v UK=1.71 SW v UK=1.92	SW v AU=0.78, 1.62 AU v UK=1.11, 2.63 SW v UK=1.28,2.88	SW v AU=0.529 **AU v UK=0.015** **SW v UK=0.002**	205 (16.5)
No	331 (80.2)	338 (80.7)	372 (89.9)				1041 (83.6)
If it were paid for, would you participate in professional development about food and nutrition education?							
Yes	367 (88.9)	366 (87.4)	387 (93.5)	SW v AU=0.80 UK v AU=1.59 UK v SW=1.98	SW v AU=0.52, 1.25 UK v AU=0.94, 2.70 UK v SW=1.22, 3.23	SW v AU=0.327 UK v AU=0.087 **UK v SW=0.006**	1120 (89.9)
No	46 (11.1)	53 (12.7)	27 (6.5)				126 (10.1)
I have undertaken training and/or professional development (PD) to teach my students about:							
Nutrition							
Strongly agree/agree	122 (29.5)	174 (41.5)	135 (32.6)	SW v AU=1.90 UK v AU=1.15 SW v UK=1.65	SW v AU=1.45, 2.50 UK v AU=0.86, 1.54 SW v UK=1.27, 2.14	**SW v AU<0.0005** UK v AU=0.337 **SW v UK<0.0005**	431 (34.6)
Neither agree nor disagree	53 (12.8)	81 (19.3)	53 (12.8)				187 (15.0)
Disagree/strongly disagree	238 (57.6)	164 (39.1)	226 (54.6)				628 (50.4)
Food skills							
Strongly agree/agree	94 (22.8)	125 (29.8)	88 (21.3)	SW v AU=1.51 UK v AU=0.83 SW v UK=1.81	SW v AU=1.15, 1.99 UK v AU=0.62, 1.12 SW v UK=1.38, 2.36	**SW v AU=0.003** UK v AU=0.228 **SW v UK<0.0005**	307 (24.6)
Neither agree nor disagree	68 (16.5)	96 (22.9)	66 (15.9)				230 (18.5)
Disagree/strongly disagree	251 (60.8)	198 (47.3)	260 (62.8)				709 (56.9)
Food sustainability							
Strongly agree/agree	101 (24.5)	165 (39.4)	88 (21.3)	SW v AU=2.07 UK v AU=0.85 SW v UK=2.43	SW v AU=1.57, 2.72 UK v AU=0.64, 1.14 SW v UK=1.86, 3.17	**SW v AU<0.0005** UK v AU=0.283 **SW v UK<0.0005**	354 (28.4)
Neither agree nor disagree	72 (17.4)	85 (20.3)	66 (15.9)				223 (17.9)
Disagree/strongly disagree	240 (58.1)	169 (40.3)	260 (62.8)				669 (53.7)

FNS policies							
Policies about teaching FNS in the curriculum							
Yes	118 (28.6)	214 (51.1)	204 (49.3)	SW v AU=4.52 UK v AU=3.23 UK v SW=0.72	SW v AU=3.04, 6.70 UK v AU=2.19, 4.77 UK v SW=0.49, 1.06	**SW v AU<0.0005** **UK v AU<0.0005** UK v SW=0.091	536 (43.0)
Unsure	161 (39.0)	145 (34.6)	126 (30.4)				432 (34.7)
No	134 (32.5)	60 (14.3)	84 (20.3)				278 (22.3)
Policies about food sustainability (e.g., managing food waste, using seasonal food, etc)							
Yes	61 (14.8)	214 (51.1)	37 (8.9)	SW v AU=31.0 UK v AU=0.98 SW v UK=31.60	SW v AU=17.87, 53.83 UK v AU=0.59, 1.65 SW v UK =18.29, 54.58	**SW v AU<0.0005** UK v AU=0.944 **SW v UK<0.0005**	312 (25.0)
Unsure	188 (45.5)	179 (42.7)	227 (54.8)				594 (47.7)
No	164 (23.0)	26 (39.7)	150 (36.2)				340 (27.3)
Presence and use of infrastructure							
Does your school have a food (e.g., vegetable, herb) garden that can be used for teaching purposes?							
Yes, used for teaching	168 (40.7)	32 (7.6)	111 (26.8)	AU v SW=19.94 AU v UK=3.63 UK v SW=5.49	AU v SW=13.76, 28.90 AU v UK=2.60, 5.10 UK v SW=3.94, 7.66	**AU v SW<0.0005** **AU v UK<0.0005** **UK v SW<0.0005**	311 (25.0)
Yes, not used for teaching	146 (35.4)	33 (7.9)	94 (22.7)				273 (21.9)
Unsure	15 (3.6)	13 (3.1)	12 (2.9)				40 (3.2)
No	84 (20.3)	341 (81.4)	197 (47.6)				622 (49.9)
Does your school have a food waste management system that can be used for teaching purposes?							
Yes, used for teaching	155 (37.5)	60 (14.3)	61 (14.7)	AU v SW=2.98 AU v UK=3.59 UK v SW=0.83	AU v SW=2.19, 4.07 AU v UK=2.58, 4.99 UK v SW=0.61, 1.14	**AU v SW<0.0005** **AU v UK <0.0005** UK v SW=0.251	276 (22.2)
Yes, not used for teaching	77 (18.6)	65 (15.5)	44 (10.6)				186 (14.9)
Unsure	37 (9.0)	48 (11.5)	50 (12.1)				135 (10.8)
No	144 (34.9)	246 (58.7)	259 (62.6)				649 (52.1)
Does your school have a kitchen/cooking facilities that can be used for teaching purposes?							
Yes, used for teaching	144 (34.9)	170 (40.6)	158 (38.2)	SW v AU=1.39 UK v AU=0.77 SW v UK=1.82	SW v AU=1.03, 1.88 UK v AU=0.56, 1.04 SW v UK=1.36, 2.43	**SW v AU=0.031** UK v AU=0.086 **SW v UK<0.0005**	472 (37.9)
Yes, not used for teaching	98 (23.7)	99 (23.6)	47 (11.4)				244 (19.6)
Unsure	16 (3.9)	15 (3.6)	17 (4.1)				48 (3.9)
No	155 (37.5)	135 (32.2)	192 (46.4)				482 (38.7)
Barriers to FNS education							
I do not have adequate funding							
Yes	207 (50.1)	159 (38.0)	287 (69.3)	AU v SW=1.92 UK v AU=1.81 UK v SW=3.48	AU v SW=1.43, 2.57 UK v AU=1.33, 2.46 UK v SW=2.60, 4.65	**AU v SW<0.0005** **UK v AU<0.0005** **UK v SW<0.0005**	653 (52.4)
No	206 (49.9)	260 (62.1)	127 (30.7)				593 (47.6)

I do not have adequate teaching and learning resources and materials							
Yes	186 (45.0)	161 (38.4)	202 (48.8)	AU v SW=1.38 UK v AU=1.08 UK v SW=1.49	AU v SW=1.04, 1.85 UK v AU=0.80, 1.45 UK v SW=1.13, 1.97	**AU v SW=0.028** UK v AU=0.619 **UK v SW=0.005**	549 (44.1)
No	227 (55.0)	258 (61.6)	212 (51.2)				697 (55.9)
I do not get support from my school management to teach this							
Yes	124 (30.0)	64 (15.3)	67 (16.2)	AU v SW=2.43 AU v UK=2.31 UK v SW=1.05	AU v SW=1.71, 3.46 AU v UK=1.61, 3.3 UK v SW=0.72, 1.53	**AU v SW<0.0005** **AU v UK<0.0005** UK v SW=0.789	255 (20.5)
No	289 (70.0)	355 *84.7)	347 (8.8)				991 (79.5)
It is not my role to teach this at school							
Yes	92 (22.3)	72 (17.2)	32 (7.7)	SW v AU=0.77 AU v UK=3.13 SW v UK=2.41	SW v AU=0.54, 1.10 AU v UK=1.99, 4.92 SW v UK=1.55, 3.76	SW v AU=0.156 **AU v UK<0.0005** **SW v UK<0.0005**	196 (15.7)
No	321 (77.7)	347 (82.8)	381 (92.3)				1050 (84.3)
Students are not interested in learning this							
Yes	42 (10.2)	59 (14.1)	16 (3.9)	SW v AU=1.49 AU v UK=2.67 SW v UK=3.98	SW v AU=0.96, 2.32 AU v UK=1.43, 4.98 SW v UK=2.24, 7.06	SW v AU=0.078 **AU v UK=0.002** **SW v UK<0.0005**	117 (9.4)
No	371 (89.8)	360 (85.9)	398 (96.1)				1129 (90.6)
Parents do not support this being taught at school							
Yes	62 (15.0)	15 (3.6)	26 (6.3)	AU v SW=4.76 AU v UK=2.62 UK v SW=1.81	AU v SW=2.62, 8.64 AU v UK=1.57, 4.39 UK v SW=0.94, 3.49	**AU v SW<0.0005** **AU v UK <0.0005** UK v SW=0.074	103 (8.3)
No	351 (85.0)	404 (96.4)	388 (93.7)				1143 (91.7)
I don't experience any challenges about teaching food and nutrition							
Yes	46 (11.1)	76 (18.1)	32 (7.7)	SW v AU=2.05 UK v AU=0.85 SW v UK=2.43	SW v AU=1.35, 3.12 UK v AU=0.51, 1.41 SW v UK=1.56, 3.78	**SW v AU=0.001** UK v AU=0.517 **SW v UK<0.0005**	154 (12.4)
No	367 (88.9)	343 (81.9)	382 (92.3)				1092 (87.6)

AU=Australia, SW=Sweden, UK=United Kingdom; Associations analysed using logistic regression (see Appendix 2); Significant p-values (p<0.05) indicated in bold

Qualitative results

Five themes were constructed from thematic analysis of the three open-ended questions that sought insights deemed important by teachers. These are explained below, and detailed in Appendix 3 with illustrative quotes.

Theme 1: Teachers perceive FNS education as important for students

Teachers considered FNS education as important for children's health, and described needing to '*educate children about… vitamins/minerals in different food and the benefits for their mind and bodies'*[T410-AU] and teaching students to '*select nutritious choices'*[T150-AU]. Some linked this to health and learning difficulties, reflecting that FNS education could improve students' health and wellbeing. Several teachers used FNS education to build '*skills the children will need in the future, such as spreading butter on bread,* [and] *having skills to cook simple food for themselves'*[T237-AU]. They emphasised student engagement in FNS activities, and particularly with hands-on, experiential learning such as growing, cooking and eating food.

Theme 2: Tensions exist in perceived responsibilities and priorities for FNS education

Tensions in perceived responsibilities of families, teachers, schools and broader society in FNS education were evident. Many teachers considered parents to be responsible for FNS education, including '*teaching children ethics, health,* [and] *manners'*[T500-AU] and '*broadening their children's eating habits'*[T1161-SW]. However, family food practices were also a barrier to FNS education. Some teachers were conscious of having '*no control over a student's breakfast, lunch or dinner'*[T21-AU], and needing to respect family food decisions. Teacher perceptions about their own roles in FNS education were mixed. FNS education was a personal priority for some, whilst others explicitly stated this was not their priority. Similarly, there were differences in perceptions about school-level prioritisation for FNS education. Beyond the school, some teachers emphasised societal responsibilities, stating that '*society/families/media/gov*[ernment] *policies'*[T471-AU] all need to play a role in educating children about FNS.

Theme 3: FNS education must be sensitive to the varying needs of children and families

Teachers described the need to be sensitive to child- and family-factors that influenced children's food behaviours. Limited food autonomy and diverse eating behaviours were important child-factors. Teachers discussed challenges for students with additional needs, including '*behaviours that limit their food, diets and understanding'*[T607-UK], and emphasised the importance of developing food skills for these students for future independent living. Allergies, restrictive eating and concerns about the link between food education and eating behaviours were also prevalent. Teachers discussed how food provided from home was '*greatly impacted by the financial situation of the community/families'*[T1035-UK] and noted that '*families and parents need to be active*

participants'[T15-AU] in FNS education for it to be effective. Teachers emphasised avoiding shame and judgement when talking about food at school, and agreed that '*teaching food sustainability and nutrition needs to be met with sensitivity'*[T561-AU]. Some discussed using 'food-neutral' language and age-appropriate strategies to empower students and encourage positive food relationships and behaviours.

Theme 4: FNS practices vary across schools

Teachers described a wide variety of FNS practices across schools. Some schools had limited or no strategies in place regarding FNS education, whilst others described one-off activities such as a '*healthy living week'*[T645-UK] or '*visit from the public dental service'*[T973-SW]. Incidental learning through discussions was common, particularly during mealtimes. The idea of '*alternating theory with practice'*[T1130-SW] was also important, and several teachers discussed their school's sustainable living or kitchen garden program where theory and practice could be integrated. Other teachers integrated FNS education into curriculum subjects such as *Home Economics, Biology, Chemistry and Mathematics'*[T919-SW], '*the creative arts, Literacy and Numeracy'*[T64-AU] and *'Health, and Design* [and] *Technology*[T484-AU]. Several teachers discussed whole-of-school and community approach to FNS education, including how food-related activities contributed to the school's culture and broader community connections. Teachers commonly described their school's practices for dealing with food waste. These ranged from comprehensive, integrated approaches, for example, where waste was collected by the council and '*used for biogas* [renewable gas produced from organic waste]'[T315-SW], to smaller-scale initiatives like '*school worm farms or compost bins'*[T346-AU] or a '*nude food reward'*[T590-AU]. Differences in food provision practices were also evident. For example, some Swedish teachers described comprehensive approaches to free healthy and sustainable school meals, whilst some UK teachers described challenges to free school meals, particularly food waste. Some Australian teachers explained that students could purchase food via a school 'tuck shop' or lunch ordering system, though menu offerings were generally considered unhealthy. Across countries, the broader eating environment was considered important, and this could either promote or hinder a positive food culture at school.

Theme 5: School-based FNS practices are influenced by broad ranging factors

FNS practices were influenced by a broad range of factors, including whether this was prioritised in government curricula. Few teachers stated their national curriculum included FNS education, with more emphasising this was '*not a statutory requirement'*[T802-UK]. Government curricula were considered overcrowded and teachers discussed deprioritising FNS education in favour of subjects against which school success was measured, notably Literacy and Mathematics. Teachers explained that school demographics influenced FNS education, with smaller, low socioeconomic position and rural schools described as being *'at a disadvantage when it comes to*

resourcing [and] *staffing'*[T528-AU] for FNS initiatives. Some teachers worked in schools where '*food traditions differ widely among students'*[T1026-SW], identifying that cultural differences '*need to be respected… and upskilling provided to staff'*[T176-AU] to support culturally sensitive FNS education. The physical school site further influenced opportunities for FNS education. Some teachers were from well-resourced schools with established infrastructure, and others had limited or inadequate facilities for teaching FNS. Some teachers indicated this was due to local planning and funding issues and class size.

Teacher circumstances, and particularly their food-related knowledge was considered to influence FNS education practices. Whilst some teachers drew on professional qualifications to inform their teaching, others relied on personal experiences, leading to concerns about the impact of personal biases. Limited pre-service and in-service education opportunities for teachers was identified as a key challenge. Teacher education was considered an important strategy to address these challenges, though a lack of both pre-service and in-service PD opportunities for teachers was identified. Teacher workload, stress and burnout further impacted their capacity to implement FNS activities. They discussed being time-poor, and unable to integrate FNS education into their teaching unless it was part of a core curriculum. Beyond this, human resources, including paid school staff and community volunteers, as well as leadership and community support were all perceived to influence FNS education practices at school.

Discussion

This transnational analysis explored approaches to FNS education in primary schools in Australia, Sweden and the UK, including country-specific associations. Novel findings regarding FNS education practices, teacher perceptions and attributes and factors influencing FNS education, as well as country-specific associations are discussed below.

FNS education practices

A novel finding from this study is that only a third of teachers reported FNS was taught frequently (fortnightly or more). Frequency of FNS education was reportedly higher in Sweden than Australia or the UK, potentially due to Sweden's mandatory Home Economics curriculum which emphasises food and practical cooking skills (24, 25). Few studies have investigated frequency of FNS education at school, though the limited evidence available suggests this varies from <1 to 13 hours per school year (36-42). However, studies suggest a minimum of 10-15 hours of nutrition education is needed to improve students' nutrition knowledge and skills (43), whilst up to 50 hours is needed to support behaviour change (44). Our findings suggest the amount of FNS education delivered in primary schools is likely inadequate to enable meaningful changes in

knowledge and behaviour. Strategies to increase the delivery of school-based FNS education are warranted, representing an important area for future research and practice.

Most teachers in the present study used a cross-curriculum approach to FNS education, primarily integrating this into Science, Health/Physical Education, Humanities and Social Sciences and Literacy. Previous studies have investigated integration of nutrition education into core curriculum subjects, (45-47), and scoping review evidence suggests this approach improves academic outcomes in nutrition and core subjects, facilitates sustained delivery without adding teaching time, and is accepted by teachers (48). Notably, cross-curricular food education is influenced by teachers' priorities and competencies (49), potentially resulting in inconsistent implementation. However, the widespread use of this approach in the current study suggests potential scope for consistent delivery of cross-curricula FNS education. Teachers in the present study largely sourced teaching materials from teacher-specific websites, though almost half created their own resources. Previous studies suggest teachers perceive FNS education resources to be outdated or limited (20). However, comprehensive, curriculum-aligned resources are available in several countries, including *Food – A Fact of Life* in the UK (50) and *freshSNAP* (51) in Australia, indicating a need to enhance teacher awareness of resource availability.

Teacher perceptions and attributes

It is widely recognised that teachers consider food and nutrition education to be important (20, 40, 52), though evidence about teacher perceptions of food sustainability education is limited. Two small qualitative studies suggest teachers perceive food sustainability education as important but under-prioritised (49, 53). Our findings that 75% of teachers considered food sustainability education as very/extremely important, and almost half considered nutrition, food skills and food sustainability education as equally important, extend this emerging body of evidence. A novel finding was that teachers considered FNS education as equally important to all mandatory curriculum subjects except Literacy and Mathematics. This likely reflects the widespread emphasis on Literacy and Mathematics for assessing school performance in Australia (54), Sweden (55) and the UK (56). However, the equal weighting of importance of FNS education against other subjects, and the finding that teachers agreed schools should teach FNS education and have supportive curriculum policies in place indicates teacher support for a larger, or even mandatory focus on FNS education in government curricula. Indeed, in this study and in previous research, teachers have emphasised that prioritisation of food education within curricula (38, 57), including through cross-curriculum integration (58) enables effective teaching in this discipline.

Most teachers reported having knowledge, skills, understanding, and confidence to teach FNS, though reports of self-efficacy were lower for food sustainability than nutrition and food skills education. This finding aligns with emerging evidence that teachers value food sustainability may lack knowledge and confidence to teach it effectively (59), and that health dimensions may be more prominent than sustainability dimensions within food systems education (60). Future research should therefore explore strategies to improve teachers' self-efficacy in food sustainability education.

Influencing factors

In the current study, few teachers had had undertaken PD regarding FNS education, had funding for FNS activities or PD, or worked in schools with FNS-related policies. Teachers considered these factors as well as time, teaching resources, physical infrastructure, human resourcing, and curriculum and school leadership priorities as having an important influence on their FNS teaching practice, reflecting an extensive body of existing literature (20, 38, 39, 41, 52, 57, 58, 61). Notably, when compared to their Australian and UK counterparts, Swedish teachers were most likely to have undertaken PD to teach FNS, to have funding for FNS teaching activities, to report not experiencing barriers to teach FNS and to be from schools with policies in place about food sustainability. Whilst inclusion of mandatory Home Economics in the Swedish curriculum likely explains these results to some degree, the holistic approach to student education and development within the Swedish school system may also be influential. The development of FNS knowledge and skills is critical to the evolution of the child as an individual being and a participant within a social context (62). As a democratic welfare state, the Swedish education model focuses on social learning as well as a holistic focus on the personal development of the child (63). Sweden's progressive and holistic approach to student education may therefore provide insight as to why Swedish schools in the current study were more likely to have embedded practices that support FNS education than Australian and UK schools which have more traditional, academic and structured school education models.

This is the first study to investigate the presence of school-based infrastructure for experiential food-related learning. Whilst teacher support for school-based nutrition education is well established (52, 64), teachers in this study also supported the presence of food gardens, waste management systems and cooking facilities for experiential food education, which is a novel finding. Whilst implementation of experiential learning at school is complex and constrained by practicality, time, resources and 'real-life' learning spaces (65), our findings suggest teachers are receptive to this pedagogical approach for FNS education. This is important given systematic review evidence that experiential food education at school multiple benefits for children's food-related knowledge, attitudes and behaviours (66-68).

There were substantial differences in the presence infrastructure across different countries. Food gardens and waste management systems were more commonly available for experiential learning in Australian schools, which could be due to integration of sustainability in the Australian curriculum as a cross-cutting theme (19). However, curriculum integration alone may be insufficient to drive food sustainability education. For example, a US study of 171 primary school teachers found only 30% of teachers in Washington (where sustainability is included in State learning standards) and Montana (which does not have sustainability learning standards) delivered FNS education, with no differences between States (69). Indeed, other factors may contribute to the higher prevalence of infrastructure for sustainable food education in Australia. Australia has a strong food gardening culture (70), and the climate allows for a wide variety of seasonal produce to be grown and harvested across the school year (71). Government funded school programs which integrate sustainability such as the Stephanie Alexander Kitchen Garden Program (72) and Sustainability Victoria's ResourceSmart Schools (73) are also well established in Australia. Our findings that Australian schools were most likely to use gardens and food waste management systems as pedagogical tools are therefore unsurprising. However, Swedish schools were most likely to have cooking facilities available for teaching. This reflects findings from a study of Sweden's Home Economics curriculum where 88% of teachers reported having access to fully equipped teaching kitchens (74). Access to teaching kitchens may be due to the emphasis on food skills within the mandatory Home Economics subject, however, it cannot be assumed that this is categorically the case. Notably, although English schools are mandated to teach cooking to students, in the current study, reports of supportive mechanisms for achieving this (e.g., frequency of teaching, school policies, teacher PD, access to funding) were more common in Sweden than the UK. This could be due to geo-cultural differences, particularly those related to the perceived role of schools in Swedish society.

A novel finding from this study is that when infrastructure for experiential FNS education was present, it was not always used for teaching. This indicates strategies to enable experiential FNS education at school are warranted. Particularly, strategies are needed to ensure that when infrastructure is present, it is effectively utilised, for example, by providing practical guidance, curriculum resources, staffing support and sufficient time, to maximise the educational value of these facilities.

Tensions in responsibilities for FNS education

Despite consensus among teachers that FNS education is important, qualitative findings revealed tensions in perceived responsibilities for teaching students about food. Whilst some teachers described FNS education as part of their role, others considered this the role of parents and society. This dissonance reflects previous literature which positions food education on a delicate boundary between public and

private life (75). Indeed, in previous studies some teachers have described FNS education as their professional responsibility (52, 61), and others have considered this a family responsibility (76, 77). In the current study, further tensions existed in priorities for FNS education at the school level. Although some schools actively integrated FNS education into curricula and broader practices, teachers more commonly reported that this was not a school priority. However, the success of health-promoting school practices largely depends on school-level commitment and ownership (78). Whilst governments establish broad curriculum frameworks, school leaders largely decide how curricula are implemented. This may explain the variations in commitment to FNS education described by teachers in the current study. Fostering mental models that prioritise FNS education among school leaders is therefore a critical step towards strengthening the uptake and long-term implementation of FNS education at school.

Approaching FNS education with sensitivity to child and family factors

Teachers in the current study emphasised the need to approach FNS education with sensitivity, given the diverse needs of children and families. Consistent with previous studies, they discussed challenges including children's food autonomy (79), food selectivity (80) and fussiness (81), allergies (82), restrictive eating behaviours (83) and family finances (84). Some teachers described using food-neutral language, avoiding terms such as 'good'/'bad' or 'healthy'/'unhealthy' when talking about food at school. This 'neutrality' in food education is a novel concept based on the premise that all foods are morally equal, and that no foods are inherently 'good'/'bad' or 'healthy'/'unhealthy' (85). However, there is a paucity of research in the field of food-neutral education, with no studies to date investigating food-neutral approaches to FNS education in primary schools (86). Given teachers in the current study used this teaching approach, research is needed to determine whether food-neutrality is an effective pedagogy for building FNS knowledge and skills in primary school students.

Implications for research, policy and practice

This research identified novel findings regarding FNS education in Australia, Sweden and the UK, with implications for research, policy and practice. FNS was taught most frequently in Sweden, where supportive mechanisms, including policies, teacher PD and funding were most common. This may reflect the integration of mandatory Home Economics in the school curriculum, which includes a focus on food skills, nutrition and food sustainability education.

These findings can be used to advocate for reorienting social and political norms across countries to position FNS education as a central, mandatory component of school curricula. Notably, achieving this will require policymakers, schools, health advocates, researchers and communities to work together, whilst recognising the influence of geopolitical climates and cultures. However, strategies can be implemented to support

this change. Discourse across school communities is needed to navigate the delicate interplay between schools and families regarding FNS education. This includes discussions, collaborations and research with government, school and community stakeholders to generate a shared understanding of responsibilities for FNS education across school and home environments. Research is also needed to understand best-practice methods for delivering age-appropriate FNS education at school in a way that is sensitive to the individual needs of the child and family.

Structural systems are needed in the school environment to support FNS education at school. School timetabling and curricula need to include allocated space for FNS education, which needs to be supported by human, physical and financial resourcing. Where available, teachers should be informed of where to source shelf-ready, reputable FNS curriculum resources, particularly those which integrate cross-curricular learning. Where curriculum resources are not available, these need to be developed. Importantly, teachers need to be supported through inclusion of FNS education in pre-service teaching degrees, coupled with in-service education for teachers already working in the sector. This includes education in both well-established and new pedagogical approaches that are sensitive to the needs of children and families.

Strengths and limitations

A strength of this study was the integrated framing of FNS education, including nutrition, food skills, and the emerging concept of food sustainability education. Whilst these terms were defined based on published literature, standardised definitions do not exist, particularly for food sustainability education. As such, respondent interpretation of these terms may have varied. The transnational survey was informed by existing research and tested for face validity by researchers across the three countries, though construct validity and reliability were not formally tested. The potential for semantic nuances in survey interpretation and cultural bias cannot be ruled out, though a rigorous translation process involving multiple native English- and Swedish-speaking researchers was used to help minimise these risks. As recruitment occurred via social media, mailing lists, and school listings, the survey reach and response rate could not be determined. The voluntary, self-reported nature of the survey and moderate completion rate may have introduced self-selection and desirability bias. However, the study aimed to capture comparable data from teachers in different countries, and an online survey was considered the most effective method for achieving this.

The cross-sectional and exploratory design of the study means country-specific causal inferences cannot be made and findings may not be generalisable to the broader international context. However, the large sample included teachers across year levels and school sizes, indicating that perceptions of a diverse group of respondents were captured. Moreover, the predominance of teachers who were female and working in public schools indicates the sample reflected characteristics of the teaching workforce

in Australia (87, 88), Sweden (89, 90) and the UK (91, 92). Moreover, the even split of teachers across countries reduced potential sampling bias whilst allowing for more reliable statistical comparisons of FNS education in the different countries.

Conclusion

This transnational analysis of FNS education across Australia, Sweden and the UK found that whilst teachers consider FNS education to be important, implementation varies across schools and countries. Overall, FNS was taught infrequently, and teachers reported low levels of PD, funding and policy support for FNS education at school. The study identified tensions in perceived responsibilities for FNS education, and that school-based FNS education needs to be sensitive to the needs of children and families. The transnational analysis found that FNS education was taught most frequently in Sweden, where teachers reported higher levels of PD, funding and policy support than their Australian and UK peers. Overall, there is a need to reposition FNS education as a core curriculum priority at the government- and school-level. Beyond this, structural elements including allocated curriculum time, human, physical and financial resourcing, pre-service teacher education and in-service PD, and curriculum-aligned resources are needed to support teachers in delivering FNS education. Ultimately, this has the potential to equip children with the knowledge, skills and values needed to navigate complex challenges related to food, health and sustainability.

Abbreviations:

AU: Australia

AUD: Australian dollars

FNS: Food, nutrition and sustainability

GBP: Great British Pound

HE: Home Economics

HPE: Health/Physical Education

OECD: Organisation for Economic Co-operation and Development

PD: Professional development

REDCap: Research Electronic Data Capture

SEK: Swedish Krona

STEM: Science, Technology, Engineering and Mathematics

UK: United Kingdom

Declarations:

Ethics approval and consent to participate:

Ethical approval was obtained from the Deakin University Human Ethics Advisory Group (Reference Number HEAG-H 127_2022) in line with the *Australian Code for the Responsible Conduct of Research (2018)* and Australia's *National Statement on Ethical Conduct in Human Research (2025)*. The ethics review and approval adheres to the *World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Participants*. All respondents provided voluntary and informed consent to participate in the study and could enter a draw to win one of five vouchers per country to the value of AUD50/SEK350/GBP30.

Consent for publication:

Not applicable.

Availability of data and materials:

The datasets used and/or analysed for this study are available from the corresponding author on reasonable request.

Competing interests:

Not applicable.

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Authors' contributions:

JVK, AOB, CM, JN and CL contributed to the conception and design of the study. JVK developed the data collection tool for the Australian context with support from AOB, CM and JN. JVK led data acquisition for the study overall and led data acquisition in Australia. CL and FT adapted the survey for the Swedish context, led data acquisition in Sweden and managed translation of the data collection tool and survey responses. DO and JVW adapted the survey for the UK context and led data acquisition in the UK. JVK conducted the transnational data analysis and interpretation and drafted the manuscript. AOB undertook quality checks for analysis of qualitative data. All authors took part in revising the manuscript, gave approval for this version to be published, and agreed to be accountable for all aspects of the work.

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