FOOD LITERACY AND CRITICAL CITIZENSHIP AMONG ADOLESCENTS: A MIXED-METHODS EXPERIMENTAL STUDY ON TRANSFORMATIVE EDUCATIONAL INTERVENTIONS

Fabiola Palmiero
Università degli studi della Campania Luigi Vanvitelli
palmierofabiola97@gmail.com

Giovanni Tafuri
University of Rome Tor Vergata
giovannitafuri@uniparthenope.it

Double Blind Peer Review

Citation
Palmiero, F., & Tafuri, G. (2026). Food literacy and critical citizenship among adolescents: A mixed-methods experimental study on transformative educational interventions. *Italian Journal of Health Education, Sport and Inclusive Didactics*, *10*(1).
https://doi.org/10.32043/gsd.v1i1.1689

Doi: https://doi.org/10.32043/gsd.v1i1.1689

Copyright notice:
© 2026 The Author(s). This is an open access, peer-reviewed article published by Cares S.r.l. – REN Press and distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

renpress.it/index.php/gsdj
ISSN: 3103-5744

ABSTRACT
This study examined the effectiveness of a Critical Food Systems Pedagogy intervention in promoting food literacy, critical thinking, and self-efficacy among adolescents. Using a quasi-experimental design with 124 students aged 14–16, the intervention integrated school gardens, peer education, service-learning, and digital modules. Results showed significant improvements in food literacy, self-efficacy, critical awareness, and social responsibility, supporting the value of transformative educational models.

KEYWORDS
Food Literacy; Adolescents; Pedagogy; Health.

Received 2026-05-10
Accepted 2026-07-12
Published 2026-07-15

1. Introduction

The contemporary global food system is a complex ecosystem characterised by profound structural inequalities and systemic contradictions. On the one hand, there is a growing availability of ultra-processed foods, which are affordable but nutritionally poor; on the other, economic, social and geographical barriers persist, limiting access to fresh and healthy foods for large segments of the population (Monteiro et al., 2019; Popkin et al., 2020). This situation simultaneously contributes to the spread of seemingly opposing phenomena, such as obesity and malnutrition, highlighting the syndemic nature of contemporary food-related issues (Swinburn et al., 2019; UNICEF, 2023).

In recent years, numerous studies have highlighted how the global dietary transition is closely linked to processes of urbanisation, market globalisation and the transformation of agri-food supply chains (HLPE, 2020; FAO, 2022). In particular, the rise in consumption of ultra-processed foods has been linked to poorer health outcomes, including obesity, type 2 diabetes and cardiovascular disease (Srour et al., 2020; Lane et al., 2021). At the same time, conditions of food insecurity persist, affecting above all the most vulnerable socio-economic groups and contributing to widening health inequalities (Loopstra, 2020; Gundersen & Ziliak, 2021).

In this context, the food environment is heavily influenced by digital media and marketing strategies, which contribute to the creation of obesogenic environments, particularly for younger age groups. Social media platforms, influencers and targeted advertising strategies amplify adolescents' exposure to unhealthy dietary models (Kelly et al., 2021; Vandevijvere et al., 2022). Recent studies show that interaction with food-related digital content significantly influences food preferences, consumption behaviours and the perception of social norms (Coates et al., 2019; Qutteina et al., 2022). Adolescents, in particular, are highly vulnerable to these dynamics, due to a developmental stage characterised by heightened social sensitivity, identity formation and a need for belonging (Sawyer et al., 2018; Ares et al., 2023).

In this context, food literacy (FL) emerges as a strategic and multidimensional response. It is not limited to the mere acquisition of nutritional knowledge, but includes cognitive, practical and socio-emotional skills that enable individuals to interact consciously with the food system (Vidgen & Gallegos, 2014; Slater et al., 2018). More recent studies have further expanded the concept, including critical and civic dimensions, such as the ability to understand the ethical, environmental

and political implications of food choices (Cullen et al., 2021; Truman et al., 2021; Silva et al., 2023).

From this perspective, FL is a dynamic and situated construct that develops through the interaction between the individual and their context. It encompasses skills in planning, selecting, preparing and consuming food, as well as the ability to critically interpret food-related information and systems (Perry et al., 2017; Ronto et al., 2020). The contemporary approach to FL also emphasises the transformative dimension, recognising the role of education in promoting sustainable behavioural and social change (Thomas & Irwin, 2022).

The relationship between FL and health literacy is particularly significant. Health literacy, defined as the ability to access, understand and use information to make health-related decisions (Nutbeam, 2000; Sørensen et al., 2012), represents a fundamental basis for the development of FL. However, whilst health literacy operates predominantly at an informational and cognitive level, FL translates these skills into concrete daily practices, integrating cultural, social and environmental dimensions (Truman et al., 2021). Recent studies highlight how high levels of FL are associated with better dietary habits, greater decision-making autonomy and a reduction in risky behaviours (Palumbo et al., 2022; Poelman et al., 2023).

From a developmental perspective, adolescence represents a crucial phase for the acquisition of dietary skills. During this period, young people develop greater autonomy in their consumption choices, whilst the influence of peers and the media becomes predominant (Story et al., 2020; Neufeld et al., 2022). At the same time, this is a highly malleable phase, in which targeted educational interventions can have lasting effects on behaviours and lifestyles (Sawyer et al., 2018).

This study is based on two main theoretical models: the Social Ecological Model and Self-Determination Theory. The first model emphasises how eating behaviours are influenced by multiple interconnected levels, including individual, relational, community and structural factors (Golden & Earp, 2012). The second highlights the role of intrinsic motivation and the fulfilment of fundamental psychological needs (autonomy, competence and relatedness) in promoting sustainable behavioural change (Ryan & Deci, 2020).

In the educational context, there is therefore a need to move beyond transmissive and knowledge-based approaches—which are often ineffective in producing lasting change—in favour of transformative models based on experience, active participation and critical reflection (Mezirow, 2000; Sterling, 2014). In this regard, Critical Food Systems Pedagogy represents a particularly relevant theoretical framework (Classens & Sytsma, 2020). This approach considers food not merely as

nourishment, but as a pedagogical tool through which to analyse the interconnections between health, the environment, the economy and social justice.

Empirical evidence suggests that educational interventions based on active methodologies – such as school gardens, service learning, peer education and digital learning – are particularly effective in promoting FL (Davis et al., 2015; Sarti et al., 2017; Bailey et al., 2019; Medeiros et al., 2022). In particular, school gardens foster experiential learning and a connection with natural systems, whilst peer education strengthens identification and self-efficacy (Morgan et al., 2020). Furthermore, the integration of digital and gamified tools helps to increase engagement and reach vulnerable populations (Fleming et al., 2021; Lu et al., 2023).

A further emerging theme in recent literature concerns the link between food literacy and global citizenship. Food choices are increasingly recognised as political and social acts, capable of influencing environmental sustainability, economic equity and human rights (IPCC, 2022; FAO, 2023). In this sense, educating for FL also means promoting critical awareness and collective responsibility towards the global food system.

In light of these considerations, this study contributes to the international debate by proposing an integrated and transformative educational intervention aimed at promoting FL and citizenship skills among adolescents. The approach adopted combines cognitive, experiential and socio-emotional dimensions, with the aim of fostering not only the acquisition of knowledge but also the development of critical thinking and agency.

2. Objectives and Hypotheses

Objectives of the study

This study aims to:

1. Assess the effectiveness of a transformative educational intervention in improving levels of food literacy among adolescents;
2. Analyse the impact of the intervention on psychological variables such as self-efficacy, intrinsic motivation and sense of agency;
3. Explore, through qualitative methodologies, changes in cognitive and social representations of food;
4. Investigate the role of the educational experience in promoting forms of active and informed citizenship.

Research hypotheses

- H1**:** Students in the experimental group will show a statistically significant increase in food literacy compared to the control group;
- H2: The intervention will produce a significant increase in levels of self-efficacy and intrinsic motivation;
- H3**:** Programme participants will develop greater critical awareness of the food system;
- H4: Experiential educational practices will foster the emergence of pro-social and sustainability-oriented attitudes.

3. Methodology

Research design

A quasi-experimental pre-test/post-test design with a non-equivalent control group was adopted, as this is considered particularly suitable for educational research conducted in real-world school settings, where the individual randomisation of students is often difficult to implement for organisational, ethical and pedagogical reasons. In schools, in fact, students are generally organised into pre-existing classes, and their random assignment to different experimental conditions could interfere with teaching continuity, timetable organisation and the balance of the class group.

The quasi-experimental design nevertheless allows the effectiveness of an educational intervention to be assessed by comparing an experimental group**,** involved in the food literacy programme, with a control group**,** which continues with standard curricular activities. Both groups underwent assessments before and after the intervention, in order to observe any changes in levels of food literacy, health literacy, self-efficacy and motivation.

The choice of a pre-post design allows us to measure not only the differences between the groups at the end of the programme, but also the internal evolution of each group over time. In this way, it is possible to distinguish, at least partially, the effects attributable to the intervention from any initial differences among the participants. Before the programme began, the two groups were compared in terms of socio-demographic variables and baseline scores on the assessment tools, in order to verify basic comparability.

The methodological approach adopted is a convergent mixed-methods approach. In this model, quantitative and qualitative data are collected during the same

research period, analysed separately and subsequently integrated during the interpretative phase. This choice responds to the need to evaluate the intervention not only in terms of measurable effectiveness, but also in terms of understanding the educational, motivational and relational processes that may explain the observed changes.

The quantitative component aims to identify statistically significant changes in the dimensions under study using standardised tools validated by the scientific literature. It allows the impact of the intervention to be estimated by comparing the pre-test and post-test scores of the experimental group and the control group.

The qualitative component, on the other hand, allows for an in-depth exploration of the meaning students attribute to the educational experience. Through focus groups, reflective diaries and participant observation, it is possible to explore changes in representations of food, in the perception of one's role as a consumer and citizen, in the ability to recognise the pressures of food marketing, and in the awareness of the social and environmental implications of food choices.

The integration of quantitative and qualitative data is a central element of the research design. The numerical results allow us to verify whether the intervention produces detectable effects, whilst the narrative and observational data help us understand how and why these effects manifest themselves. For example, an increase in food literacy scores can be interpreted more fully if accompanied by qualitative evidence relating to students' greater ability to critically read food labels, discuss the role of advertising, or link their food choices to issues of sustainability and social justice.

The research design can therefore be summarised in four main phases:

1. Preliminary phase**,** dedicated to defining the sample, obtaining informed consent and administering pre-tests;
2. Intervention phase**,** during which the experimental group participates in the transformative educational programme, whilst the control group follows the standard curriculum;
3. Final assessment phase**,** in which post-tests are administered and concluding qualitative data are collected;
4. Interpretative integration phase, in which quantitative and qualitative data are linked to formulate an overall assessment of the intervention's effectiveness.

The use of a mixed-methods quasi-experimental design is consistent with the complex nature of food literacy, which cannot be reduced to a simple acquisition

of nutritional information, but involves practical skills, attitudes, motivations, critical thinking and forms of social participation.

Sample and context

The sample consists of 124 students from two upper secondary schools located in comparable socio-economic contexts.

- Average age: 15.2 years (SD = 0.7);
- Balanced gender distribution;
- Heterogeneous socio-economic background.

Inclusion criteria

- Regular enrolment at the school;
- Ability to understand and complete standardised questionnaires;
- No diagnosed serious eating disorders;
- Willingness to participate in the entire programme.

Exclusion criteria

- Diagnosis of severe cognitive impairments not supported by compensatory aids,
- Participation in parallel intensive nutritional education programmes;
- Prolonged absences or discontinuity in participation;
- Lack of informed consent.

Detailed description of the intervention

The educational intervention, lasting a total of 12 weeks, was designed according to an integrated, interdisciplinary and transformative approach, consistent with the principles of active pedagogy and Critical Food Systems Pedagogy. The programme's structure is based on the integration of cognitive, experiential, social and digital dimensions, with the aim of promoting not only the acquisition of knowledge but also the development of practical skills, critical thinking and civic awareness.

The design of the intervention was guided by empirical evidence highlighting the effectiveness of multimodal approaches in food education, capable of engaging students at various levels (Davis et al., 2015; Bailey et al., 2019; Medeiros et al., 2022). Furthermore, the programme was designed in line with the Social-Ecological

Theory, operating at multiple levels (individual, relational and community-), and with Self-Determination Theory, promoting autonomy, competence and relatedness.

The intervention comprises four main, interconnected components.

School garden (experiential learning)

The school garden is the experiential hub of the programme. Students were involved in practical cultivation activities, including soil preparation, sowing, watering and harvesting. At the same time, they monitored the life cycle of the plants, documenting changes through diaries and digital tools.

This component is based on the principles of experiential learning (Kolb, 1984), according to which knowledge is constructed through direct experience and reflection on it. Numerous studies show that school gardens improve nutritional knowledge, food preferences and willingness to consume fruit and vegetables (Savoie-Roskos et al., 2017; Morgan et al., 2020).

Furthermore, the garden promotes an understanding of the concepts of seasonality, sustainability and the food supply chain, helping to develop a systemic view of food (FAO, 2022; Williams & Dixon, 2013). Through direct contact with nature, pupils also develop a greater sense of environmental responsibility and ecological awareness (Blair, 2009; Ohly et al., 2016).

Peer education

Peer education involved the selection and training of student facilitators, who led group activities, discussions and opportunities for peer-to-peer exchange. The activities were designed to encourage active participation, the sharing of experiences and the collaborative construction of knowledge.

This approach is based on the assumption that peers are a particularly influential source during adolescence. Studies show that peer education is effective in promoting healthy behaviours, thanks to mechanisms of identification, social modelling and mutual reinforcement (Turner & Shepherd, 1999; Sawyer et al., 2018).

In the field of nutrition, interventions based on peer education have demonstrated positive effects on knowledge, attitudes and eating behaviours (Stock et al., 2007; White et al., 2009). Furthermore, this methodology helps to strengthen the sense of self-efficacy and agency, central elements in Self-Determination Theory.

Service learning

Service learning represented the civic and social dimension of the intervention. Students collaborated with local organisations (e.g. third sector organisations, voluntary groups), participating in awareness-raising activities on issues such as food sustainability, food waste and equitable access to food.

This methodology integrates learning and community service, promoting the development of transferable skills and active citizenship (Eyler & Giles, 1999; Celio et al., 2011). Recent studies highlight that service learning fosters critical thinking, empathy and civic engagement, contributing to a deeper understanding of social issues (Aramburuzabala et al., 2019; Salam et al., 2019).

In the context of food education, service learning enables students to link their daily choices to global issues, such as food security and environmental sustainability (FAO, 2023; IPCC, 2022). Furthermore, it strengthens their sense of social responsibility and their ability to act as informed citizens.

Digital modules and gamification

The digital component of the intervention included the use of interactive MOOCs, quizzes, simulations and activities involving critical analysis of social media content. Students explored topics related to food marketing, nutrition labels and digital food communication.

The integration of gamification relies on the use of playful elements (scores, challenges, immediate feedback) to increase motivation and engagement. The literature highlights how such strategies are particularly effective in educational contexts, especially with adolescents (Deterding et al., 2011; Hamari et al., 2014).

Recent studies show that digital interventions can significantly improve health and food literacy skills, facilitating access to educational content even in vulnerable contexts (Fleming et al., 2021; Lu et al., 2023). Furthermore, critical analysis of social media contributes to the development of critical thinking and the ability to decode persuasive messages (Qutteina et al., 2022).

Integration of components

A distinctive feature of the intervention is the synergistic integration of the four components. The school garden provides a concrete experiential foundation, peer education fosters the relational dimension, service learning connects learning to

social reality, whilst the digital modules expand opportunities for access and engagement.

This integration is in line with the literature, which emphasises that multi-factor interventions are more effective in promoting lasting behavioural change (Contento, 2016; Thomas & Irwin, 2022).

Control group

The control group followed a traditional programme based on lectures, characterised by the delivery of theoretical content without experiential or participatory components. This choice allows for a comparison of the effectiveness of a transformative approach against a conventional teaching model, which remains widespread in school settings.

Assessment tools

Quantitative tools

1. Food Literacy Assessment Tool (FLAT)**:** Measures knowledge, skills and attitudes and Validated in European contexts;
2. Health Literacy Survey Questionnaire (HLS-EU-Q)**:** Assesses the ability to access, understand and use health information;
3. General Self-Efficacy Scale (GSE)**:** Measures perceived personal efficacy;
4. Basic Psychological Needs Scale (BPNS)**:** Assesses autonomy, competence and relatedness

Qualitative tools

- Semi-structured focus groups (average duration: 60 minutes);
- Weekly reflective diaries;
- Participant observations.

Data analysis procedures

Data analysis was conducted using an integrated approach, consistent with the convergent mixed-methods design, in order to ensure an in-depth understanding of both the effects of the intervention and the underlying processes. The analytical procedures were divided into two main sections: quantitative analysis and qualitative analysis, which were subsequently integrated in the final interpretative phase.

Quantitative analysis

Quantitative analysis was carried out using standard statistical software (e.g. SPSS, R), following a structured sequence of steps designed to ensure the robustness and validity of the results.

Preliminary analyses

Before proceeding to the inferential analyses, preliminary checks were carried out:

- Descriptive analyses (mean, standard deviation, distribution of scores);
- Normality check (Shapiro-Wilk test);
- Test for homogeneity of variances (Levene's test);
- Analysis of missing data, handled using imputation techniques where necessary.

This phase allowed us to verify the suitability of the data in relation to the assumptions of parametric analysis.

Comparisons between groups

To compare the experimental group and the control group:

- The t-test for independent samples was used on pre-test scores to verify the initial equivalence of the groups;
- Subsequently, the same test was applied to post-test scores to assess differences between groups at the end of the intervention.

Within-subject analysis (pre-post)

To analyse changes over time:

- A repeated measures ANOVA (within-between design) was used, with: time factor (pre-test vs post-test) and group factor (experimental vs control)

This analysis allowed us to identify:

- main effects of time;
- primary effects of the group;
- time × group interaction**,** considered a key indicator of the intervention's effectiveness.

Calculation of the effect size

To estimate the practical relevance of the results, in addition to statistical significance, the following were calculated:

- Cohen's d for between-group comparisons;
- partial η^2 (eta squared) for the ANOVA.

The values were interpreted according to standard conventions:

- small ($d \approx 0.20$);
- medium ($d \approx 0.50$);
- large ($d \geq 0.80$).

Correlation analysis and relationships between variables

Correlation analyses (Pearson or Spearman, depending on the distribution) were conducted to explore the relationships between:

- Food Literacy;
- Health Literacy;
- Self-efficacy;
- Intrinsic motivation.

This phase enabled us to investigate the links between cognitive and psychological dimensions, in line with the theoretical framework based on Self-Determination Theory.

Qualitative analysis

The qualitative analysis was conducted using a rigorous and systematic approach, aimed at exploring the meanings attributed by students to the educational experience.

Data preparation

- Full transcription of the focus groups;
- Collection and organisation of reflective diaries;
- Review of observation notes.

All data were anonymised to ensure the confidentiality of participants.

Coding process

The analysis followed three progressive stages:

- Open coding**:** initial identification of emerging units of meaning;
- Axial coding**:** organisation of codes into thematic categories;
- Selective coding**:** construction of interpretative macro-themes.

This process enabled a shift from a descriptive reading to a deeper theoretical understanding.

Thematic analysis

Thematic analysis was adopted according to Braun & Clarke (2006)**,** structured in six phases:

1. Familiarisation with the data;
2. Generation of initial codes;
3. Identification of themes;
4. Review of themes;
5. Definition and naming of themes;
6. Report production.

This methodology has enabled the identification of recurring patterns in students' experiences, relating to:

- development of critical thinking;
- food awareness;
- personal empowerment;
- active citizenship.

Reliability and validity of the qualitative analysis

To ensure the quality of the analysis, various strategies were adopted:

- Triangulation of sources (focus groups, diaries, observations);
- Triangulation of researchers (independent coding and comparison);
- Audit trail (documentation of the analytical process);
- Member checking (validation of results with participants, where possible).

Data integration (mixed phase)

In the final phase, the quantitative and qualitative results were integrated using a convergent triangulation approach.

- The quantitative data provided evidence of the intervention's effectiveness;
- The qualitative data explained the mechanisms of change.

For example:

- An increase in food literacy was interpreted in the light of narratives highlighting greater critical awareness;
- Improved self-efficacy was associated with experiences of active participation and collaboration.

This integration allowed for a more comprehensive and nuanced understanding of the results, in line with the complexity of the phenomenon studied and with the framework of the Social-Ecological Theory, which requires a multi-level analysis of educational processes.

The approach adopted ensures:

- methodological rigour;
- interpretative depth;
- theoretical consistency.

Making the data analysis capable of capturing both the measurable effects and the educational and social transformations generated by the intervention.

5. Results

Quantitative results

The quantitative analysis was conducted with the aim of assessing the effectiveness of the educational intervention on levels of food literacy and related psychological variables. In a preliminary phase, the conditions for the applicability of parametric analyses were verified. The data showed an overall normal distribution, whilst tests for homogeneity of variances revealed no significant violations, thus allowing the use of standard inferential procedures. Furthermore, the comparison between the experimental group and the control group in the pre-test scores revealed no

statistically significant differences, confirming the substantial initial comparability of the two groups.

At the end of the intervention, comparative analyses revealed significant differences between the groups. In particular, students in the experimental group achieved significantly higher scores in Food Literacy compared to the control group. This result suggests that the educational programme had a tangible impact on skills related to understanding, selecting and managing food. Similarly, significant improvements were also observed in levels of health literacy and self-efficacy, indicating that the intervention had effects not only at the cognitive level, but also at the psychological and motivational levels.

A further level of analysis was provided by repeated-measures ANOVA, which allowed us to observe changes over time within the groups. The results revealed a significant interaction effect between time and group for food literacy, indicating that the increase observed in the experimental group cannot be attributed to external factors or simply to the passage of time, but is likely attributable to the intervention itself. Positive trends also emerged for the dimensions related to autonomy and self-efficacy, with more marked improvements in the experimental group compared to the control group.

From a practical relevance perspective, the effect size values indicate a medium-to-high impact for food literacy and a moderate impact for the psychological variables. This suggests that the intervention, despite its limited duration, was able to produce changes that were not only statistically significant but also educationally relevant.

Correlation analyses also revealed significant relationships between food literacy, self-efficacy and intrinsic motivation. In particular, higher levels of food literacy are associated with a greater perception of competence and control over food choices, as well as with more autonomous motivation. This finding appears consistent with Self-Determination Theory, according to which the development of skills promotes the strengthening of intrinsic motivation and decision-making autonomy.

Overall, the quantitative results indicate that the intervention had a significant and multidimensional impact, contributing not only to the acquisition of knowledge but also to the strengthening of psychological resources fundamental to the adoption of mindful eating behaviours.

Table 1. Descriptive statistics (pre-test and post-test)

Variable	Group	Pre-test M (SD)	Post-test M (SD)
Food Literacy	Experimental	72.3 (7.8)	78.4 (8.2)
Food Literacy	Control	71.8 (8.1)	71.1 (7.9)
Health Literacy	Experimental	32.9 (5.0)	34.7 (5.1)
Health Literacy	Control	32.5 (5.2)	31.9 (5.3)
Self-efficacy (GSE)	Experimental	27.5 (4.2)	29.2 (4.0)
Self-efficacy (GSE)	Control	27.3 (4.1)	27.1 (4.3)
Autonomy (BPNS)	Experimental	3.4 (0.6)	3.9 (0.7)
Range (BPNS)	Control	3.5 (0.7)	3.4 (0.6)

Table 2. Post-test comparisons between groups (t-test for independent samples)

Variable	t	df	p	Cohen's d
Food Literacy	3.21	122	< .01	0.65
Health Literacy	2.45	122	< .05	0.45
Self-efficacy	2.18	122	< .05	0.42
Autonomy	2.07	122	< 0.05	0.40

Table 3. Repeated measures ANOVA (time × group)

Variable	Effect	F(1,122)	p	Partial η^2
Food Literacy	Time	12.34	< .001	.09
Food Literacy	Group	8.56	< .01	.07
Food Literacy	Time × Group	9.87	< .01	.08
Self-efficacy	Time	6.45	< .05	.05
Self-efficacy	Time × Group	3.52	.06	.03
Range	Time × Group	5.12	< 0.05	.04

Table 4. Correlations between variables (Pearson r)

Variable	1	2	3	4
1. Food Literacy	—			
2. Health Literacy	.58**	—		
3. Self-efficacy	.46**	.39**	—	
4. Intrinsic motivation	.51**	.42**	.55**	—

Note: p < .01

Table 5. Effect size (interpretation)

Variable	Cohen's d	Interpretation
Food Literacy	0.65	Medium-high
Health Literacy	0.45	Medium
Self-efficacy	0.42	Medium
Autonomy	0.40	Medium

Qualitative results

The qualitative analysis allowed for a deeper exploration of the processes of change underlying the quantitative results, offering a more nuanced understanding of the transformations experienced by the students. Through the thematic analysis of focus groups, reflective diaries and participant observations, four main dimensions emerged that describe the impact of the intervention.

A first dimension concerns cognitive restructuring, which manifests itself in the shift from a predominantly individualistic and taste-centred conception of food to a broader and more systemic view. The students gradually developed a greater awareness of the relationships between food, the environment and society, demonstrating an understanding of food not merely as a personal choice, but as an element within a complex system. This shift is clearly evident in the students' accounts, which highlight a new focus on the origin of food, production processes and the ethical implications of their choices.

A second dimension concerns the development of critical thinking**,** particularly relevant in the current context characterised by heavy exposure to digital media. Students demonstrated a growing ability to analyse and decode advertising messages, recognising the persuasive strategies used in food marketing. This competence translates into a greater critical distance from media content and a heightened awareness of external influences on their choices.

A third area of transformation concerns empowerment and a sense of agency**.** Students have expressed greater confidence in their decision-making abilities and a heightened perception of control over their food choices. This change is evident not only in their statements but also through concrete behaviours, such as more conscious food selection or a willingness to change their habits. In this sense, the qualitative data reinforce the findings of the quantitative analyses regarding self-efficacy.

Finally, a dimension linked to active citizenship emerges, representing one of the most significant aspects of the intervention. Students have developed greater

awareness of issues such as environmental sustainability, food waste and equity in access to food. In some cases, this has translated into active involvement in the community and the sharing of knowledge with family members and peers, suggesting a potential multiplier effect of the intervention.

The integration of quantitative and qualitative results allows for the delineation of a coherent and comprehensive picture. The improvements observed in Food Literacy scores are, in fact, reflected in profound cognitive and cultural transformations, whilst the increase in self-efficacy is underpinned by experiences of active participation and situated learning. This convergence reinforces the validity of the results and confirms the effectiveness of the educational approach adopted.

Overall, the qualitative results highlight how the intervention has fostered not only the acquisition of skills but also a change in the way students interpret their relationship with food, contributing to the development of more aware, autonomous and socially responsible individuals.

6. Discussion

The results of this study consistently confirm the effectiveness of transformative educational approaches in promoting complex and multidimensional skills related to food literacy in adolescents. In particular, the significant increase in food literacy, accompanied by improvements in self-efficacy and intrinsic motivation, suggests that integrated educational interventions can influence not only the acquisition of knowledge but also the underlying cognitive, motivational and behavioural processes (Truman et al., 2021; Silva et al., 2023; Poelman et al., 2023).

These findings form part of a growing body of research highlighting that food literacy should be considered a multidimensional and situated construct, which develops through concrete experiences, social interactions and critical reflection (Cullen et al., 2021; Ronto et al., 2020). In this sense, the present intervention appears to have facilitated meaningful learning, capable of integrating theoretical knowledge with everyday practice, thereby contributing to the development of transferable skills.

From a theoretical perspective, the results appear consistent with the Social Ecological Model, which emphasises the importance of interactions between the individual and multi-level contexts. The intervention operated simultaneously at several levels: individual (development of skills and awareness), interpersonal (peer education), organisational (school) and community (service learning). This multi-

level integration is recognised in the literature as a key element in promoting lasting behavioural change, particularly in the context of diet (Story et al., 2020; Swinburn et al., 2019; Neufeld et al., 2022).

At the same time, the observed increase in levels of self-efficacy and intrinsic motivation can be interpreted in the light of Self-Determination Theory. According to this model, the satisfaction of basic psychological needs – autonomy, competence and relatedness – represents a fundamental prerequisite for the development of self-determined behaviours (Ryan & Deci, 2020). The proposed activities, particularly the experiential and collaborative ones, appear to have fostered precisely these conditions, enabling students to experience a sense of control over their own choices and to build skills perceived as meaningful.

One particularly significant finding to emerge from the study concerns the integration of experiential practices and digital tools. Recent literature highlights how the combined use of active methodologies and educational technologies can significantly increase student engagement and improve learning outcomes (Fleming et al., 2021; Lu et al., 2023; Sailer & Homner, 2020). In this study, the use of gamification and digital modules facilitated access to complex content, whilst practical activities (school garden, service learning) made this content concrete and contextualised. This hybrid approach appears particularly effective in addressing the characteristics of contemporary adolescents, who are deeply immersed in digital environments yet simultaneously in need of authentic and meaningful experiences (Ares et al., 2023; Qutteina et al., 2022).

A further significant aspect concerns the development of critical thinking regarding the food system and the media. In line with recent studies, participants demonstrated a greater ability to recognise the persuasive strategies of food marketing and to reflect on the social and environmental implications of their choices (Kelly et al., 2021; Vandevijvere et al., 2022). This finding is particularly important in a context characterised by digital obesogenic environments, where exposure to unhealthy food content is high and often unregulated.

Furthermore, the emergence of dimensions linked to active citizenship confirms the role of food education as a tool for promoting social awareness and collective responsibility. Recent studies highlight how sustainability-oriented educational practices can contribute to the development of global citizenship skills, fostering more equitable and sustainable behaviours (FAO, 2023; IPCC, 2022; Thomas & Irwin, 2022). In this sense, food serves as a privileged lens through which to explore the interconnections between health, the environment and social justice.

Despite the promising results, the study has certain limitations that must be taken into account when interpreting the data. Firstly, the lack of full randomisation limits the possibility of establishing definitive causal relationships, although the quasi-experimental design adopted represents a methodologically appropriate solution in real educational contexts (Shadish et al., 2002). Secondly, the presence of a possible self-selection bias may have influenced the results, as the most motivated students may have been more inclined to participate actively in the intervention.

A further limitation concerns the generalisability of the results, given the relatively small sample size and the specific geographical context. Future studies should include larger and more diverse samples in order to verify the replicability of the results in different contexts (Contento, 2016; Poelman et al., 2023).

Finally, the presence of a Hawthorne effect cannot be ruled out, whereby participants may have altered their behaviour simply in response to the awareness of being observed. However, the integration of qualitative and quantitative data helps to mitigate this risk, offering a more nuanced and coherent view of the changes observed.

Overall, the results suggest that educational interventions based on transformative, experiential and integrated approaches represent a promising strategy for addressing the challenges posed by the contemporary food system. They not only improve individual skills but also contribute to the development of informed citizens, capable of making informed and responsible decisions regarding food and health.

7. Conclusions

This study provides empirical evidence supporting the idea that food literacy can be effectively promoted through transformative, integrated and multidimensional educational approaches. The results show that interventions combining experiential learning, active participation, critical reflection and the use of digital tools are capable of significantly influencing not only knowledge, but also practical skills, motivational dispositions and the behaviours of adolescents.

In particular, the data highlight that such interventions foster the development of food literacy understood as a complex and situated competence, which includes the ability to select, understand and use food-related information, but also to critically interpret the socio-cultural context in which food choices are made. This aspect appears particularly relevant in light of the challenges posed by the

contemporary food system, characterised by strong commercial pressures and growing inequalities in access to healthy food.

A key finding from the study concerns the strengthening of students' autonomy and self-efficacy. Through activities that promote active participation and empowerment, participants developed greater confidence in their decision-making abilities, showing a greater propensity to make informed food choices. This result suggests that food education, when properly designed, can contribute to the development of cross-cutting skills that are fundamental to individual and collective well-being.

At the same time, the intervention fostered the emergence of forms of active citizenship, evidenced by the students' growing interest in issues such as environmental sustainability, food justice and the waste of resources. In this sense, food emerges as a powerful pedagogical tool, capable of connecting seemingly disparate dimensions – health, the environment, the economy and culture – and of promoting an integrated and systemic view of reality.

From a theoretical perspective, the findings reinforce the idea that meaningful learning occurs through the interaction between the individual and their context, in line with socio-ecological perspectives, and that intrinsic motivation is a key element for lasting behavioural change. The integration of practical experiences, social relationships and digital tools emerges as a particularly effective strategy for engaging adolescents and supporting deep learning processes.

In practical terms, the study suggests the importance of rethinking food education in an interdisciplinary and transformative way, moving beyond teaching models focused exclusively on the transmission of content. The structured inclusion of Food Literacy in school curricula could represent a fundamental step towards promoting healthy and sustainable lifestyles, whilst contributing to the reduction of social and health inequalities.

Despite the limitations highlighted, the results open up interesting avenues for future research. It will be important to investigate the long-term sustainability of the observed effects, as well as to explore the effectiveness of similar interventions in different socio-cultural contexts. Furthermore, further studies could investigate the role of families and communities in reinforcing and amplifying the outcomes of educational interventions.

In conclusion, this study contributes to the scientific debate by highlighting that food literacy should not be considered a secondary or sector-specific objective, but a key competence for addressing the challenges of the 21st century. Promoting a

more informed, critical and responsible relationship with food ultimately means educating individuals capable of contributing to the construction of healthier, fairer and more sustainable societies.

References

Ares, G., Machín, L., Antúnez, L., Vidal, L., Giménez, A., & Curutchet, M. R. (2023). Influence of food marketing on adolescents' food choices: A systematic review. *Appetite, 180*, 106383. https://doi.org/10.1016/j.appet.2022.106383

Aramburuzabala, P., McIlrath, L., & Opazo, H. (2019). Embedding service-learning in European higher education. *Journal of Higher Education Outreach and Engagement, 23*(3), 1–13.

Bailey, C. J., Driscoll, D. L., & Knight, E. J. (2019). Food literacy programmes: A review of the literature. *Journal of Nutrition Education and Behaviour, 51*(6), 687–697.

Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *The Journal of Environmental Education, 40*(2), 15–38.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Celio, C. I., Durlak, J., & Dymnicki, A. (2011). A meta-analysis of the impact of service-learning. *Journal of Experiential Education, 34*(2), 164–181.

Classens, M., & Sytsma, E. (2020). Food systems pedagogy: A critical approach. *Agriculture and Human Values, 37*, 123–135.

Coates, A. E., Hardman, C. A., Halford, J. C. G., Christiansen, P., & Boyland, E. J. (2019). Social media influencer marketing and children's food intake. *Pediatrics, 143*(4), e20182554.

Contento, I. R. (2016). *Nutrition education: Linking research, theory, and practice* (3rd ed.). Jones & Bartlett Learning.

Cullen, T., Hatch, J., Martin, W., Higgins, J. W., & Sheppard, R. (2021). Food literacy: Definition and framework. *Journal of Nutrition Education and Behaviour, 53*(2), 134–145.

Davis, J. N., Spaniol, M. R., & Somerset, S. (2015). Sustenance and sustainability: Maximising the impact of school gardens. *Public Health Nutrition, 18*(13), 2358–2367.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness. *Proceedings of the 15th International Academic MindTrek Conference*, 9–15.

Eyler, J., & Giles, D. E. (1999). *Where's the learning in service-learning?* Jossey-Bass.

FAO. (2022). *The State of Food Security and Nutrition in the World 2022*. Food and Agriculture Organization.

FAO. (2023). *The State of Food Security and Nutrition in the World 2023*. Food and Agriculture Organization.

Fleming, T. M., Bavin, L., Stasiak, K., Hermansson-Webb, E., Merry, S. N., & Cheek, C. (2021). Serious games and gamification for health promotion. *JMIR Serious Games, 9*(2), e21065.

Golden, S. D., & Earp, J. A. (2012). Social ecological approaches to individuals and their contexts. *Health Education & Behavior, 39*(3), 364–372.

Gundersen, C., & Ziliak, J. P. (2021). Food insecurity and health outcomes. *Health Affairs, 40*(1), 162–169.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? *Proceedings of the 47th Hawaii International Conference on System Sciences*, 3025–3034.

HLPE. (2020). *Food security and nutrition: Building a global narrative*. High Level Panel of Experts.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Intergovernmental Panel on Climate Change.

Kelly, B., Vandevijvere, S., Freeman, B., & Jenkin, G. (2021). New media but same old tricks. *Current Obesity Reports, 10*(2), 117–127.

Kolb, D. A. (1984). *Experiential learning*. Prentice Hall.

Lane, M. M., et al. (2021). Ultra-processed food and chronic disease. *BMJ, 372*, n530.

Loopstra, R. (2020). Vulnerability to food insecurity. *The Lancet Public Health, 5*(8), e416–e417.

Lu, A. S., Kharrazi, H., Gharghabi, F., & Thompson, D. (2023). Gamification for health. *Journal of Medical Internet Research, 25*, e45678.

Medeiros, L. C., et al. (2022). School-based food literacy interventions. *Nutrients, 14*(3), 567.

Mezirow, J. (2000). *Learning as transformation*. Jossey-Bass.

Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J. C., Louzada, M. L., Rauber, F., ... & Jaime, P. C. (2019). Ultra-processed foods: What they are and how to identify them. *Public Health Nutrition, 22*(5), 936–941.

Morgan, P. J., Warren, J. M., Lubans, D. R., Saunders, K. L., Quick, G. I., & Collins, C. E. (2020). Impact of school gardening. *Journal of Nutrition Education and Behaviour, 52*(1), 33–40.

Neufeld, L. M., et al. (2022). Food systems and adolescent nutrition. *The Lancet, 399*(10320), 129–146.

Nutbeam, D. (2000). Health literacy as a public health goal. *Health Promotion International, 15*(3), 259–267.

Ohly, H., et al. (2016). Effects of school gardening. *BMC Public Health, 16*, 286.

Palumbo, R., et al. (2022). Food literacy and healthy eating. *Public Health Nutrition, 25*(3), 1–10.

Perry, E. A., et al. (2017). Food literacy framework. *Appetite, 116*, 365–371.

Poelman, M. P., et al. (2023). Effectiveness of food literacy interventions. *Nutrients, 15*(4), 789.

Popkin, B. M., Corvalan, C., & Grummer-Strawn, L. M. (2020). Dynamics of the double burden of malnutrition. *The Lancet, 395*(10217), 65–74.

Qutteina, Y., De Backer, C., & Smits, T. (2022). Media influence on eating behaviour. *Appetite, 169*, 105808.

Ronto, R., et al. (2020). The role of food literacy in public health. *International Journal of Environmental Research and Public Health, 17*(3), 1–15.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation. *Contemporary Educational Psychology, 61*, 101860.

Sailer, M., & Homner, L. (2020). Gamification in education. *Educational Psychology Review, 32*, 77–112.

Salam, M., et al. (2019). The impact of service learning. *Educational Research Review, 27*, 120–135.

Sarti, A., et al. (2017). School-based nutrition interventions. *Public Health Nutrition, 20*(12), 2199–2212.

Sawyer, S. M., et al. (2018). Adolescence and health. *The Lancet, 392*(10152), 1019–1030.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs*. Houghton Mifflin.

Silva, R., et al. (2023). Food literacy and sustainability. *Sustainability, 15*(2), 1234.

Slater, J., et al. (2018). Food literacy: A review. *Canadian Journal of Dietetic Practice, 79*(2), 98–104.

Sørensen, K., et al. (2012). Health literacy model. *BMC Public Health, 12*, 80.

Srour, B., et al. (2020). Ultra-processed food intake and health outcomes. *BMJ, 365*, l1451.

Sterling, S. (2014). Separate tracks or real synergy? *Sustainability Education Review, 6*, 45–62.

Stock, S., et al. (2007). Peer education effectiveness. *Health Education Research, 22*(3), 325–336.

Story, M., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2020). Creating healthy food environments. *Annual Review of Public Health, 41*, 43–58.

Swinburn, B. A., et al. (2019). The global syndemic of obesity. *The Lancet, 393*(10173), 791–846.

Thomas, H., & Irwin, J. (2022). Food literacy interventions. *Health Promotion International, 37*(1), daab089.

Truman, E., Raine, K., & Elliott, C. (2021). Defining food literacy. *Appetite, 156*, 104960.

Turner, G., & Shepherd, J. (1999). Peer education review. *Health Education Research, 14*(2), 235–247.

UNICEF. (2023). *The State of the World's Children 2023*. UNICEF.

Vandevijvere, S., et al. (2022). Digital food marketing. *Obesity Reviews, 23*(2), e13354.

Vidgen, H. A., & Gallegos, D. (2014). Defining food literacy. *Public Health Nutrition, 17*(5), 1–9.

White, S., Park, Y. S., Israel, T., & Cordero, E. (2009). Longitudinal evaluation of peer-led health education. *Journal of School Health, 79*(10), 497–505.

Williams, D. R., & Dixon, P. S. (2013). Impact of garden-based learning. *Review of Educational Research, 83*(2), 211–235.