

## RESEARCH ARTICLE

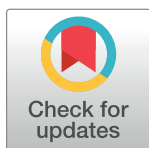
## Teaching methods for critical thinking in health education of children up to high school: A scoping review

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## Abstract

According to the World Health Organization, the improvement of people's health literacy is one of the fundamental public health challenges in the 21st century. The key issue in teaching health literacy is to develop critical thinking skills. As health literacy and critical thinking should be developed at school age, we reviewed teaching methods or educational interventions used in empirical studies focused on the development of critical thinking regarding health and implemented by teachers in preschools, primary schools, or secondary schools. We searched seven databases (Medline, Embase, Web of Science, ERIC, ProQuest, PsycArticles, and CINAHL) from inception to 20 September 2023 for any type of empirical studies. Due to the heterogeneity in interventions and inadequate reporting of results, a descriptive synthesis of studies was performed in addition to quantitative analysis. Of the 15919 initial records, 115 studies were included in the review. Most of the educational interventions focused on lifestyle-related health issues such as substance use, sexual and reproductive health, and nutrition. The popularity of health issues changed over time and depended on the geographical context. Six dimensions that differentiated the teaching methods were identified: central teaching component, central educator, pupils' activity level, teaching context, educational materials, and significance of critical thinking. Many educational interventions did not address the development of critical thinking skills in a comprehensive manner, and the significance of critical thinking varied greatly. Interventions in which critical thinking had high and very high significance applied mainly problem-solving methods and involved pupils' activity. The evidence on the effectiveness of the teaching

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methods that develop critical thinking is limited because most articles failed to provide detailed information on the teaching methods or did not examine their effects. We recommend that a checklist is developed to facilitate a detailed description of health educational interventions and thus promoting their replicability.

**Study registration:** The protocol of the review was registered in the OSF Registries on 13 January 2022 (doi: <https://doi.org/10.17605/OSF.IO/46TEZ>).

## Introduction

One of the major public health challenges in the 21st century is to improve people's health literacy [1]. Health literacy refers to an individual's ability to seek, understand, and use health information. Health literacy skills are essential for claim evaluation, data interpretation, and risk assessment. The key issue in learning health literacy is to develop knowledge, skills, motivation, and self-awareness that translate into individuals' autonomy, independence, and empowerment. These qualities enable individuals to deal with health and its determinants.

In its definition of health literacy, the World Health Organization stresses the importance of social competences, such as communication and critical thinking, which are necessary for making adequate health decisions both on daily basis [2] and in extraordinary circumstances, such as the pandemic [3]. The fundamental goal of acquiring health literacy is to develop critical thinking skills. Critical thinking means that people are able to analyze and evaluate their thought processes in order to improve them [4]. According to a widely used definition, critical thinking is "a reasoned, reflective thinking focused on deciding what to believe or do" [5]. Today, we live in a world of information, and critical thinking skills can help us think logically and clearly. The competence of critical thinking is essential because it allows people to think independently.

Considering the abundance of easily available, but not verified, information as well as global health threats such as the coronavirus disease 2019 (COVID-19) pandemic, critical thinking skills become especially important in such life domains as health [3]. People need these skills to critically assess and use information relevant to their health, and it is the key to make evidence-based health choices. For example, the COVID-19 pandemic can be viewed not only as a public health threat but also as an infodemic [6], because there was overabundance of fake news, misinformation, and conspiracy theories that have undermined the trust in health institutions and treatment procedures [7–32]. Machete et al [33] conducted a systematic review including 22 articles that were synthesized and used as evidence to determine the role of critical thinking in identifying fake news. The study confirmed that critical thinking skills are essential to recognize fake news.

In this context, it seems crucial to teach critical thinking to pupils (i.e., children up to high-school level). Fostering critical thinking is widely recognized as an integral part of developing health literacy. There are several strategies that are recommended for teaching critical thinking, including classroom discussions [34], problem-based learning [35], and questioning techniques [36, 37]. There is also evidence that peer-to-peer interaction is one of the teaching behaviors related to student gains in critical thinking [38]. However, most of these recommendations are based on theoretical works or do not relate to health-related topics. Moreover, these works refer to higher-education students, including students in a specific field (such as nursing or economics).

In this scoping review, we focused on the concept of health literacy and critical thinking as one of its main dimensions. We aimed to identify and review the teaching methods or pedagogical interventions used in empirical studies on the development of critical thinking regarding health and implemented by teachers in preschools as well as primary or secondary schools (level of education 0, 1, 2, and 3 according to the International Standard Classification of Education [ISCED]). The article presents the methods used in this process, quantitative and qualitative results, discussions of the findings, and conclusions.

## Materials and methods

We conducted the scoping review in accordance with the Joanna Briggs Institute [39] methodology for scoping reviews and in our reporting we adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) reporting statement with extension for scoping reviews [40]. We provided the filled-out checklist in [S1 Table](#). In the development of our review we followed the methods outlined in the protocol registered in the OSF Registries on 13 January 2022 [41].

## Criteria for study inclusion

For this scoping review, we considered any type of qualitative and quantitative empirical studies focusing on the development of critical thinking within the framework of health education at school by teaching subjects with content related to health (biology, chemistry, science, physical education, wellness, sexual education, health education, digital education, math, and critical thinking as a subject). Moreover, we included studies that provided information about teaching methods, training activities, or pedagogical interventions implemented by teachers or other school educators. Finally, we considered empirical studies referring to pupils in pre-school, primary (elementary) or secondary (high) schools (ISCED 0, 1, 2, 3) and to teachers from those schools.

## Search strategy

We searched the following databases: Medline, Embase, Science Citation Index with Abstracts, ERIC, ProQuest, PsycArticles, and CINAHL.

We employed the text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles, to develop a full search strategy for each database (see [S2 Table](#)). We used the following terms in the key search strategy: “health knowledge”, “health education”, “health literacy”, “critical thinking”, “schools”, “education”, “informed choice”, “choice behaviour”, “decision making”, “curriculum”, and “teaching methods”. We adapted the search strategy, including the relevant keywords and index terms, for each included database and/or information source. We screened the reference list of all included sources of evidence for additional studies. We searched databases from inception to 20 September 2023. Due to limited resources, we only included studies in English.

## Study selection and data collection

Following the search, we collated all identified citations, uploaded them into Endnote X8 (Clarivate Analytics, PA, USA), and screened using the Covidence online tool ([covidence.org](https://www.covidence.org)). We removed any duplicates using Covidence.

We performed the three rounds of calibration exercises, using 50 abstracts each downloaded into an MS Excel spreadsheet (which ensured a common understanding of the inclusion and exclusion criteria). Next, 14 authors (MMB, MŚM, MŚ, APK, APD, NO, DS, APR,

MZ, PW, WŻ, MM, SW, DK) working independently and in pairs screened the studies with respect to meeting eligibility criteria based the titles and abstracts. Thus, we obtained the full texts of potentially eligible articles. After four rounds of calibration exercises using five full texts each, 10 authors (MMB, DS, PW, SW, DK, MM, WŻ, APK, MWG, APD) working independently and in pairs screened the studies with respect to meeting eligibility criteria using their full texts. Third reviewer (MMB) resolved disagreements arising at any stage of the study selection. The core team developed and piloted the extraction form in Excel (MMB, MSM, MŚ, APD, APK, APR, MZ), and following four rounds of calibration exercises, eight reviewers (MM, SW, PW, DK, WŻ, AJ, MWG, AM) worked in pairs to extract data from the included studies into the prepiloted form. The pairs of reviewers independently extracted the data. Due to heterogeneity in interventions and inadequate reporting of results, we performed a descriptive synthesis of studies. The extracted data included specific details about the study methods, context (e.g., type of school, school location, study population), interventions, description of teaching methods focusing on critical thinking, and key findings relevant to the objectives of this review. Three authors (MMB, APD, APK) additionally checked all extractions.

### Qualitative data synthesis

To further analyze the teaching methods, we conducted a qualitative synthesis [42]. Based on the primary analysis of the extracted data, two authors (APD and APK) developed and tested a coding book in MAXQDA 2024 based on 5% of the included articles. We resolved any discrepancies in coding at this stage by discussion. We used the final coding book to code detailed information on the teaching methods and the practical strategies of their implementation provided in the articles and in external sources such as further publications or websites of the interventions. The process of summarizing and comparing the coded data as well as using graphical tools to identify patterns allowed us to precisely categorize the teaching methods into analytical themes (six dimensions of teaching methods). These themes were developed from free codes and descriptive themes.

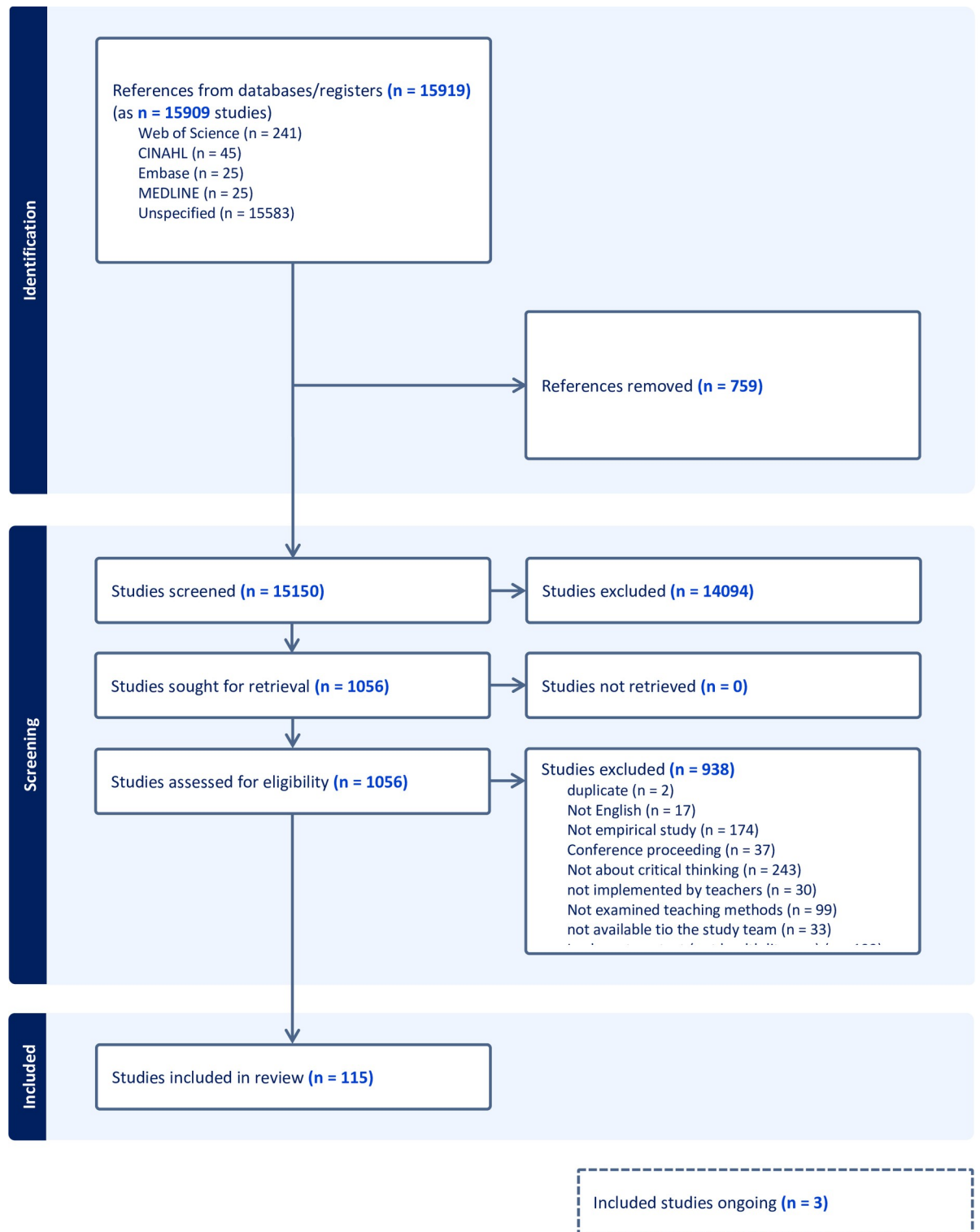
### Results

A total of 15919 records of 15909 studies were initially identified. After removing duplicates, 15150 studies were screened on the basis of the title and abstract. This yielded 1056 potentially relevant studies, which were screened based on full texts. Of the 1056 studies, 243 (25.5%) were excluded because they did not concern the development of critical thinking. Other studies were excluded because they were only theoretical ( $n = 174$ ), did not concern the population of interest ( $n = 171$ ), did not address health literacy ( $n = 132$ ), did not provide information about the teaching methods used ( $n = 99$ ), or for other reasons ( $n = 116$ ). The list of the excluded studies, along with reasons for exclusion, is available on the project website in the OSF Registries [17]. We identified 118 eligible studies, of which 3 were still ongoing [43–45]. Finally, we included 115 completed studies (Fig 1).

The included studies met the eligibility criteria and described the teaching methods used, but most of them (80%) did not examine the effectiveness of these teaching methods but interventions used in the study. Below we present the findings first referring to the quantitative and then to qualitative analysis.

### Description of the included studies

A total of 115 studies were included in this scoping review, including 65 studies reporting quantitative methods [46–113], 25 studies reporting mixed methods [114–140], and 25 studies reporting qualitative methods [7–32] (See S3 Table). Some educational interventions were



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**Fig 1. Flow diagram on the selection of studies.**

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described in more than one article. In such cases, the records were merged and assessed as one study [16, 17, 56, 70–72, 119]. The most common study design was cluster randomized (25 articles, 22%) and quasi-experimental (20 articles, 17%). The dates of article publication covered nearly 40 years. More than a half of the eligible articles were published after 2010 (74 articles, 64%) and only 12 studies were published before 2000 (10%). The included studies were conducted in various cultural contexts, but mostly in the Western societies of North America (52 articles, 45%) and Europe (34 articles, 30%). Only 14 studies were conducted in Asia (12%); 8, in Africa (7%); 5, in Australia (4%); and 2, in South America (2%). In one article, there was no information on the country [137].

Educational interventions conducted in North America covered a broad range of topics and addressed psychoactive substance use [21, 26, 50, 52, 53, 58, 61, 65, 67, 75, 80, 83, 85, 92, 95, 117, 140], lifestyle (including nutrition, physical activity) [57, 60, 63, 77, 87, 89, 96, 100, 135], sexual and reproductive health (SRH) [19, 49, 82, 94, 98, 108, 120, 127, 128] (including AIDS and HIV prevention [21, 59, 73, 86, 93]), public health [18, 31, 66, 69, 78, 79, 87, 90, 111], and somatic health [25, 87, 123, 131, 140]. The topic of mental health has only emerged in publications from the last three years [100, 104, 138].

Most studies conducted in Europe concerned lifestyle, including both nutrition and/or physical activity interventions [7, 9, 11, 22, 24, 46, 91, 97, 103, 106, 109, 126, 134], public health [8, 12, 13, 29, 47, 88, 101, 105, 139], and psychoactive substance use [7, 15, 48, 51, 84, 114, 122]. Four papers concerned somatic health [22, 30, 97, 125] and five—mental health [68, 97, 99, 109, 113]. Only two educational intervention addressed sexual health [28, 115].

Most studies conducted in Asia addressed sexual health [14, 56, 119, 132, 136, 141], including AIDS and HIV prevention [56, 116, 119, 133, 136]. Mental health was addressed by three studies [64, 112, 141], psychoactive substance use by two [74, 84]; and somatic health by one study [121]. In the last three years, studies have emerged whose educational interventions focused on lifestyle [27, 110]. Among African studies reporting on educational interventions, there were six articles that focused on SRH [10, 55, 62, 118, 124, 132], and one intervention that was dedicated to health claims [130].

Finally, research conducted in Australia concerned such health topics as psychoactive substance use [70–72, 81], lifestyle [16, 17], as well as public [23, 102] and mental health [23], while an educational intervention conducted in South America covered the topic of SRH [20].

## Health issues in education interventions

Interventions reported in the included articles addressed a broad range of health issues, and the thematic focus of the interventions had changed over time (Table 1). Until 2000, the prevailing topics in health education were substance use and SRH, in the following decades also

**Table 1. Health issues addressed in the tested interventions.**

Decade of publication	Health issues						
	Psychoactive substance use	SRH	Nutrition	Public health	Physical activity	Somatic health	Mental health
up to 1990	2	1	0	0	0	0	0
1991–2000	3	3	2	3	1	1	0
2001–2010	12	8	6	8	3	2	3
2011–2020	9	13	10	8	6	4	3
from 2021	5	6	9	8	4	4	7

The number of publications calculated in rows. The colors indicate a relative number of publications calculated in the rows, with red indicating the highest and blue the lowest number. Only the most important health issues covered in the interventions were coded.

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nutrition, issues connected with public health, physical activity, as well as somatic and mental health gained interested of teachers and stakeholders in the field.

Almost one in three studies published over the last 40 years tested substance use interventions (27%). Half of them discussed nicotine [50, 51, 53, 58, 61, 67, 70, 74, 75, 80, 83, 85, 95, 114] and drugs [21, 26, 52, 53, 65, 70–72, 74, 76, 81, 84, 85, 87, 140] and four in ten concerned alcohol [15, 48, 53, 71, 72, 83, 85, 92, 117, 122, 137].

The same number of interventions (31; 27.5%) covered SRH, and specifically sexual health [10, 28, 55, 78, 112, 115, 132], reproductive health [20, 49, 62, 82, 94, 115, 120, 127, 136], sexual abstinence [20, 49, 55, 73, 82, 124, 127, 128, 136], contraceptive methods [62, 94, 120, 124], menstruation [14], gender roles [32, 108, 119, 132], healthy relationships [32, 55, 119], sexually transmitted disease [82, 86, 118, 119], and AIDS and HIV prevention [21, 55, 56, 59, 73, 82, 86, 116, 118, 119, 124, 133, 136].

Slightly less studies (27; 23.5%) tested an intervention on nutrition (23.5%) [8, 11, 16, 17, 22, 23, 46, 57, 60, 77, 87, 89, 91, 96, 97, 103, 109, 110, 112, 123, 125, 126, 135, 140–142]. Public health problems, such as health care [21], violence [13, 18, 78], global health [8], organ donation [88], anti-microbial resistance [107], zoonosis [101], use of medicine [12], and bioethical dilemmas linked to health [47], social inequalities [31] were taught in 25% of reported interventions. Various forms of physical activity were promoted in every tenth intervention (11%) [7, 9, 16, 17, 63, 77, 87, 89, 97, 135, 142].

Specific somatic health issues such as cancer, cardiovascular system, diabetes, eye or oral health were discussed in 11% of the articles [22, 25, 30, 64, 87, 97, 112, 121, 125, 131]. Even fewer articles reported interventions on mental health issues, such as emotional regulation [64, 89, 97], resilience [23] and healthy relationships [23, 111, 119]. Nearly every third tested intervention covered more than one health issue [7, 16, 17, 21–23, 50, 55, 64, 77, 78, 82, 86, 87, 89, 97, 109, 111, 112, 119, 124–127, 135, 136, 140, 141]. Topics such as epidemic or pandemic were discussed only in a few articles, mainly with regards to HIV and AIDS [73, 116, 133] or social inequality during the COVID-19 pandemic [31]. Vaccinations were discussed in interventions generally linked to infectious disease [66] or aimed at increasing the uptake of specific vaccination, i.e. HPV [102].

Interventions reported in 94 articles (82%) were initiated by external bodies, such as universities, and were tested in several schools in a selected region (Table 2). Nearly half (51) of the studies tested regionally based interventions. In 31 studies, the interventions were tested locally, typically in one or in several schools. The remaining interventions were evaluated in bigger samples, either on a national (16 articles) or international level (5 articles). Nine of the interventions were pilot interventions. Moreover, the studied interventions varied in terms of the level of education. Most of them were tested in high schools/secondary schools (60, 52%); 30, in primary/elementary schools (26%); 24, in middle schools (21%); and only 1 intervention was tested in preschools. Interventions were conducted by schoolteachers, peer educators, or both. Half of the studied interventions were preceded by teachers' training (57 articles, 50%) and/or peer leaders training (13 articles, 11%). Only every third intervention provided pupils with additional materials, such as booklets [22, 32, 74, 77, 102, 124], handouts [49, 78, 117], audiovisual materials [20, 74, 90, 99, 107, 115], textbooks [84, 85, 130], recipes [57] newsletters [28, 46], exercise book [129], and student guide [111].

Interventions tested in the included articles were typically taught in class (50%), most often in an interdisciplinary form as part of multiple school subjects, such as health education or sexual health education, math, family life education, social sciences, media literacy, language, philosophy, home economy, science, and, less typically, during a single subject such as health education (23 articles), biology (3 articles), science (3 articles), sexual health education (3 articles), language (2 articles), critical thinking (1 article), social sciences (1 article), math (1

Table 2. Characteristics of educational interventions in health.

Study ID	Reach of intervention	Type of school	Who initiated intervention	Subject	Teacher training	Peer training	Additional materials for pupils	Assessment of intervention effect	Details of teaching method
Aghazadeh 2020	Pilot	Elementary/ Primary school	External body	Math, Science, Language arts	Y	N	Y	Y	Y
Anderson 2005	Local	Elementary/ Primary school	External body	NR	Y	N	Y	Y	Y
Alekseeva 2015	National	Elementary/ Primary school and High school/ Secondary school	External body	NR	Y	Y	N	Y	Y
Allsop 2022	Regional	High school/ Secondary school	External body	Health education	Y	N	N	Y	N
Arauz Ledezma 2021	Local	High school/ Secondary school	External body	NR	Y	N	Y	Y	Y
Araujo 2017	National	High school/ Secondary school	External body	Biology, philosophy	Y	N	N	N	N
Audrey 2006	Regional	High school/ Secondary school	External body	Math, science, literacy, social studies	N	N	N	Y	Y
Aventin 2020	National	High school/ Secondary school	External body	Humanities/ social sciences, math	Y	N	Y	N	Y
Banas 2021	Local	High school/ Secondary school	Unclear	Unclear	N	N	N	N	N
Basen-Engquis 1997, Coyle 1999	Regional	High school/ Secondary school	External body	Unclear	Y	Y	Y	Y	Y
Bell R 1993	Regional	High school/ Secondary school	Unclear	Health education	N	N	N	Y	N
Bell M 2005	Regional	Elementary/ Primary school	External body	Unclear	Y	N	N	Y	N
Begoray 2009	Regional	High school/ Secondary school	External body	Health education	N	N	Y	Y	N
Bond 2004	Regional	High school/ Secondary school	External body	English, Health, Personal development	N	Y	Y	Y	N
Bonnesen 2023	National	High school/ Secondary school	External body	Danish, Social Studies, Physical Education and Sport, Introduction to Natural science	Y	N	N	Y	Y
Borawski 2009	Regional	High school/ Secondary school	External body	Health education, school nurses	Y	N	N	Y	Y
Brinez 2019	Local	Middle school	Internal body	Biology	N	N	N	Y	Y
Brotman 2013	Regional	High school/ Secondary school	External body	Health education, Science, English	Y	N	N	Y	N
Bruselius-Jensen 2014, 2017	Regional	Elementary/ Primary school	External body	Math	Y	N	Y	Y	Y
Bruselius-Jensen 2017	International	Elementary/ Primary school	Mixed	NR	N	N	Y	Y	Y
Byers 2003	Regional	Middle school	Already existing in the curriculum	Sexual health education	N	N	N	NR	N
Caria 2011	International	Middle school	External body	NR	Y	N	N	Y	Y
Carlsson 2012	International	High school/ Secondary school	External body	NR	N	N	N	Y	Y
Carolan 2007	Regional	Middle school	Unclear	Unclear	N	Y	N	Y	Y

(Continued)



Table 2. (Continued)

Study ID	Reach of intervention	Type of school	Who initiated intervention	Subject	Teacher training	Peer training	Additional materials for pupils	Assessment of intervention effect	Details of teaching method
Cheng 2008	Regional	High school/ Secondary school	External body	NR	Y	NR	NR	Y	Y
Contento 2007	Local	Middle school	Unclear	Science	Y	NR	N	Y	Y
Cooper 2022	Regional	Elementary/ Primary school	External body	NR	Y	N	N	Y	N
Davis 2023	Regional	High school/ Secondary school	External body	NR	Y	N	N	Y	Y
Dela Fuente-Anuncibay 2023	Regional	Elementary/ Primary school	External body	NR	NR	N	N	Y	Y
Denny 2006	Unclear	Upper elementary, middle school and High school/ Secondary school	External body	Health education	Y	NR	Y	Y	Y
DiCicco 1984	National	High school/ Secondary school	External body	Health education, Science	Y	N	N	Y	Y
Dinaj-Koci 2015	Local	High school/ Secondary school	External body	Health education	Y	N	N	Y	Y
Dunton 2012	Regional	Elementary/ Primary school	External body	NR	N	N	N	Y	Y
Fage-Butler 2019	Regional	Elementary/ Primary school	External body	Critical thinking	N	NR	NR	Y	Y
Flay 1985	Regional	Middle school	External body	Health education	N	N	N	Y	Y
Ghimire 2020	Local	Middle school	External body	Health education, Critical thinking	N	N	N	Y	Y
Giles 2001	Regional	Middle school	External body	Health education	Y	N	NR	Y	Y
Giles 2010	Unclear	Middle school	External body	NR	Y	NR	NR	Y	Y
Gonzales 2004	Regional	High school/ Secondary school	External body	Health education	NR	N	N	Y	Y
Hanewinkel 2004	International	High school/ Secondary school	External body	NR	Y	N	NR	Y	Y
Haruna 2018	Local	High school/ Secondary school	External body	Health education	NR	NR	N	Y	Y
Hassan 2014	Local	Elementary/ Primary school	Unclear	Humanities/ social sciences	Y	N	N	Y	Y
Hecht 2006	Regional	Middle school	External body	Science and Health education	Y	N	N	Y	N
Heo 2021	National	High school/ Secondary school	External body	NR	N	N	N	Y	N
Jacque 2016	Regional	High school/ Secondary school	Internal body	Biology	N	N	N	Y	Y
Johnson 1985	Regional	High school/ Secondary school	Unclear	Health education	N	N	N	Y	Y
Jones 2022	Local	High school/ Secondary school	Internal body	NR	N	Y	N	N	Y
Kafewo 2008	Local	High school/ Secondary school	External body	NR	N	NR	N	N	Y
Kapp 1980	Pilot	Middle school	External body	NR	Y	N	N	Y	N
Kärkkäinen 2018	Local	Elementary/ Primary school	Other	NA	N	N	N	Y	Y

(Continued)

Table 2. (Continued)

Study ID	Reach of intervention	Type of school	Who initiated intervention	Subject	Teacher training	Peer training	Additional materials for pupils	Assessment of intervention effect	Details of teaching method
Kärkkäinen 2019	Local	High school/ Secondary school	External body	Health education	N	N	N	Y	Y
Keselman 2007	Pilot	Middle school	Already existed	Biology	N	N	N	Y	Y
King 2008	Local	High school/ Secondary school	External body	Unclear	N	N	N	Y	Y
Klim-Confort 2023	Local	Middle school	Unclear	Language arts	Y	N	Y	Y	N
Kocken 2015	National	High school/ Secondary school	External body	NR	Y	N	Y	Y	Y
Kostanjevec 2017	Pilot	Elementary/ Primary school	External body	Home economics	N	N	N	Y	Y
König 2022	National	High school/ Secondary school	External body	NA	N	N	Y	Y	Y
Kupersmidt 2010	Regional	Elementary/ Primary school	External body	NR	Y	N	Y	Y	Y
Lakin 2008	Local	Elementary/ Primary school	Internal body	Citizenship curriculum, Science, History, Geography, English	N	N	N	Y	Y
Layzer 2017	Regional	High school/ Secondary school	External body	NR	N	Y	N	Y	Y
Lin 2021	Regional	High school/ Secondary school	External body	Health education	Y	N	Y	Y	Y
Manesis 2022	Local	Elementary/ Primary school	External body	NR	N	N	N	Y	Y
Mason-Jones 2011	National	High school/ Secondary school	External body	Sexual education, Health education, Life orientation	N	N	Y	Y	Y
Maticka-Tyndale 2010	Regional	Elementary/ Primary school	External body	Health education, Sexual education, Math, English, Critical thinking	N	N	N	Y	Y
Midford 2013, 2014, 2016	Regional	High school/ Secondary school	External body	Health education	Y	N	N	Y	Y
Marques 2013	Regional	High school/ Secondary school	External body	Health education	Y	Y	N	Y	Y
Marshman 2021	National	High school/ Secondary school	External body	Personal health, Social education/ Health and Wellbeing	N	N	Y	N	Y
Mesman 2021	Regional	High school/ Secondary school	External body	NR	Y	N	N	Y	Y
Modell 2023	Regional	Middle school	External body	NR	Y	N	Y	Y	N
Moreno 2018	Regional	Middle school	External body	Health education, Health Literacy, Biology, Populations statistics, Epidemiology, Social studies	N	N	N	Y	Y
Moreira 2010	Local	Elementary/ Primary school	External body	Civic education, Portuguese language, Environment studies, Math	Y	N	N	Y	N
Neumann 1999	Local	High school/ Secondary school	External body	Environmental health education, Math	Y	N	Y	Y	Y

(Continued)

Table 2. (Continued)

Study ID	Reach of intervention	Type of school	Who initiated intervention	Subject	Teacher training	Peer training	Additional materials for pupils	Assessment of intervention effect	Details of teaching method
Nielsen 2023	Regional	Unclear	External body	NR	Y	N	Y	N	N
Nygaard 2021	Local	High school/ Secondary school	External body	Handicraft, Health education	Y	N	Y	Y	Y
Nsangi 2017	National	Elementary/ Primary school	External body	NR	Y	N	Y	Y	Y
O'Hara 1996	Local	High school/ Secondary school	External body	Language arts Classes	N	Y	Y	Y	Y
Orsini 2019	Regional	High school/ Secondary school	External body	NR	Y	N	N	Y	N
Pacheco 1991	Local	High school/ Secondary school	External body	English, communication skills, Health education	N	N	Y	Y	Y
Palmer 2018	Regional	Middle school	External body	Physical education	NR	N	N	Y	Y
Paul 2019	Regional	High school/ Secondary school	External body	Biology, Critical thinking	Y	N	N	Y	Y
Petrie 2017	Regional	High school/ Secondary school	External body	Health education	N	N	Y	Y	Y
Perry 1989, Kelder 1995	Regional	Middle school	External body	NR	N	Y	N	Y	Y
Pieczka 2019	Regional	High school/ Secondary school	External body	Health education, Alcohol education	N	Y	N	Y	Y
Ponsford 2021	Regional	High school/ Secondary school	External body	Sexual education	Y	N	N	Y	Y
Porcu 2022	Regional	Elementary/ primary school	External body	NR	Y	N	Y	Y	N
Rajan 2017	Regional	Middle school	External body	Health education	Y	N	N	Y	Y
Reubsat 2005	National	High school/ Secondary school	External body	Health education	N	N	N	Y	Y
Resnicow 1993	Regional	Elementary/ Primary school	External body	Classroom generalist, Health education	Y	N	N	Y	Y
Riggs 2007	Pilot	Elementary/ Primary school	External body	NR	N	N	N	Y	Y
Ridge 2002	Regional	High school/ Secondary school and Elementary/ primary school	External body	Health education	Y	N	N	Y	N
Rogow 2013	International	High school/ Secondary school	External body	Science and humanities, Health education	Y	N	Y	Y	N
Ruge 2016	Pilot	High school/ Secondary school	Other	Health education, Nutritional education	N	N	N	Y	N
Santos-Beneit 2019	Regional	Elementary/ Primary school	External body	NR	Y	N	Y	Y	Y
Seal 2006	Local	High school/ Secondary school	External body	Health education	N	N	Y	Y	Y
Schonfeld 2001	Pilot	Pre-school, Elementary/ Primary school	Other	Health education	N	N	N	Y	N
Scull 2022	National	High school/ Secondary school	External body	Sexual health education	NR	NR	NR	Y	Y
Shah 2011, 2017	Regional	High school/ Secondary school	External body	Health education, Physical education	N	Y	NA	Y	Y
Shensa 2016	Local	High school/ Secondary school	External body	Health education, Media literacy	N	N	N	Y	Y

(Continued)

Table 2. (Continued)

Study ID	Reach of intervention	Type of school	Who initiated intervention	Subject	Teacher training	Peer training	Additional materials for pupils	Assessment of intervention effect	Details of teaching method
Shinde 2017, 2020	Pilot	High school/ Secondary school	External body	NR	Y	N	NR	N	Y
Simoes 2021	National	Elementary/ Primary school	External body	NR	Y	N	N	Y	Y
Simon 2022	Local	High school/ Secondary school	External body	NA	Y	N	N	Y	N
Timol 2016	Regional	High school/ Secondary school	External body	NR	N	Y	N	Y	N
Tiwari 2020	Local	NR	External body	NR	NR	NR	N	Y	N
Türkyılmaz 2022	Local	Elementary/ Primary school	Unclear	Science	NR	N	N	Y	y
Velasco 2017	Regional	Middle school	External body	NR	Y	N	Y	Y	N
Venditti 2009	Pilot	Middle school	External body	NR	Y	N	Y	Y	Y
Vieira R 2016	Local	Elementary/ Primary school	Internal body	Science	N	N	N	Y	Y
Wang 2022	Local	Unclear	External body	NR	N	N	Y	Y	Y
Werle 2004	Local	Middle school	Internal body	Health education	N	N	N	Y	N
Wiist 1991	Local	Elementary/ primary school	External body	Health education	Y	Y	N	Y	Y
Williams 2023	National	Middle school	External body	NR	Y	N	Y	Y	Y
Wolfe 2009, 2011	Regional	High school/ Secondary school	External body	Health education, Physical education, Sexual education	Y	N	N	Y	Y
Yoon 2021	National	High school/ Secondary school	External body	Health education	Y	N	N	Y	N
Zion 2021	Unclear	Elementary/ Primary school	Unclear	NR	NR	N	N	Y	Y

\*NR—not reported; NA—not applicable; Y—yes; N—no.

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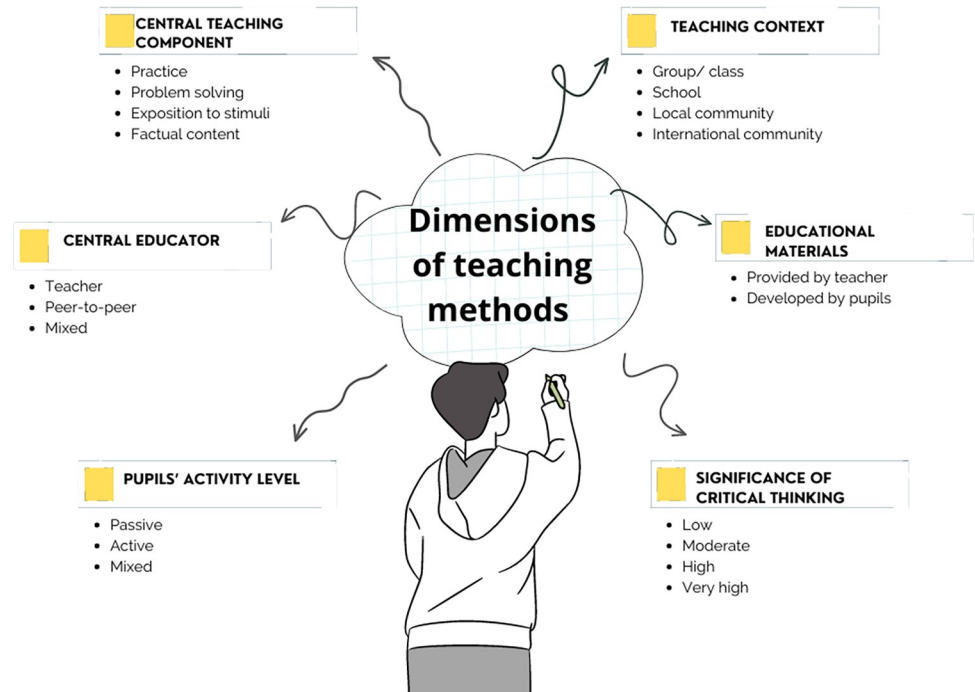
article), home economics (1 article), and physical education (1 article). Almost all of the 115 interventions were described as having “positive results”. However, in all those cases, the evaluation concerned the entire intervention rather than single teaching methods.

### Dimensions of teaching methods used in health education

We noted a vast diversity of approaches to teaching critical thinking in health education that were tested in the included studies. To comprehensively describe this variety, we identified six dimensions that differentiated the methods based on their important characteristics listed in Fig 2.

**Central teaching component.** When we looked at the teaching methods from the perspective of the central component that organized the teaching process, we distinguished four components: practice, problem solving, exposition to stimuli, and factual content. The application of the didactical approaches in health education over five decades is presented in Table 3. While hands-on and expository approaches prevailed in the 1980s, 1990s, and the first two decades of the 21st century, the importance of problem-solving methods has become more visible since 2011.

The teaching methods with practice as the central component provided pupils with instructions on where to gain knowledge, how to practice new skills, and how to develop new habits



**Fig 2. Dimensions of teaching methods tested in the included studies.**

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through experience. Pupils participated in or conducted practical activities that reflected the discussed issues. Typically, the practice-oriented methods were dedicated to developing either cognitive skills and emotional regulation or manual abilities and physical fitness. The former was used when fostering the skills of goal setting [77, 85, 87, 100, 137], decision-making [12, 25, 27, 29, 46, 61, 70–72, 74, 76, 77, 80, 84, 85, 89, 97, 102, 111, 120, 123, 126, 134–136, 138], stress management [85, 99], peer pressure resistance [21, 61, 80, 85, 95], emotions regulation [85, 89], peaceful conflict resolution techniques [29, 111, 139], differentiating healthy from unhealthy practice [11, 92, 123, 134, 135], assertiveness [87, 111], as well as values clarification and/or self-monitoring [46, 77, 84, 89, 120]. On the other hand, the subcategory of manual abilities and physical fitness included first aid [72], creative tasks [21, 73, 121], sports [9, 27, 60, 63, 80, 87, 106, 109], testing samples [140], daily menu composition and/or food preparation [24, 46, 96, 103, 123, 126, 134, 137, 142], project work [16, 57, 69], or making a video [14, 31, 67].

**Table 3. The central teaching component in health education interventions over five decades.**

Decade of publication	The central teaching component			
	practice	exposition	problem solving	factual content
up to 1990	3	3	3	2
1991–2000	5	6	2	4
2001–2010	13	12	14	10
2011–2020	26	20	26	11
from 2021	19	14	17	11

The number of publications calculated in rows. The colors indicate a relative number of publications calculated in the rows, with red indicating the highest and blue the lowest number.

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When problem-solving is the central component of a teaching approach, pupils typically detect new knowledge and apply it in a particular situation. Pupils use “triggers” from a case study or scenario to define their own learning objectives. These methods include case study analysis [11, 13, 66, 69–72, 88, 115, 116, 130, 133], problem-based learning [89, 110, 122, 123, 125], collaborative scenario-based discussions [11, 123], storytelling [84, 110], debate [52, 91, 136], Socratic questions [52, 95], brainstorming [7, 13, 14, 64, 84, 133], and educational games [16, 17, 52, 74, 84, 85, 91, 95, 116, 118, 126, 134, 137].

Teaching methods centered on exposition offer external or internal stimuli to intensify the learning process. These methods provide pupils with an opportunity to observe particular environments and collect impressions from the external stimuli to foster the understanding of a given issue (e.g., a field trip to a sexually transmitted disease clinic [86] to university hospital to talk with medical professionals and patients [21, 140]). Alternatively, they presented posters [27, 102], video games [103, 111], videos dedicated to the health topic [98, 107, 108, 110] or allow pupils to recreate situations, reflect values, or express themselves with drama [10], role-playing [13, 26, 54, 74, 90, 95], music, and dance composition [136].

Finally, in a traditional method focusing on factual content, knowledge is delivered to pupils by means of lectures, formal presentations, or textbook work. In this approach, the teacher is the primary source of information, and pupils are recipients of information. In our analysis, factual content methods were applied in 38 (34.7%) interventions [15, 17, 19, 21, 22, 27, 46, 54, 57, 67–69, 72, 74, 80, 88, 90, 92, 94, 96, 97, 101, 102, 107, 112, 116, 120, 123, 124, 130, 132, 135–137].

In 73 interventions (63.5%), more than one component was used to reach the educational objectives. Most frequently, the authors of the intervention used all methods simultaneously [17, 69–72, 74, 94, 120, 130, 137]. They also mixed the problem-solving and practice methods [24, 30, 73, 85, 89, 91, 122, 126, 141], less often problem solving, practice methods and exposition [32, 84, 113, 140] or problem-solving and exposition [98, 106, 110, 111] and the exposition and practice methods [12, 27, 102, 103, 121]. The patterns of applying various central teaching components in the intervention addressing various health issues were grouped into seven thematic categories and presented in Table 4. While practice was central to organizing the teaching process for most health issues (more than 50% of interventions related to all health topics but SRH applied practical teaching methods), it was especially prevalent in interventions teaching about nutrition and physical activity. Problem-solving and exposition were frequently, or relatively frequently, used in interventions regarding substance use and SRH. More

**Table 4. Application of the central teaching components in interventions addressing various health issues in regard to popularity of the didactic approach in particular thematic areas.**

Health issue	Central teaching component			
	practice	exposition	problem solving	factual content
psychoactive substance use	18	12	15	8
SRH	11	16	17	11
nutrition	23	12	16	10
public health	12	11	8	9
physical activity	13	6	5	6
somatic health	8	6	6	3
mental health	9	5	5	3

The number of publications calculated in the rows. The colors indicate a relative number of publications calculated in the rows, with red indicating the highest and blue the lowest number.

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than 60% of the interventions on somatic health, nutrition, and physical activity were built around more than one teaching component.

**The level of pupils' activity and central educator.** The tested teaching methods differed in terms of the level of pupils' activity. Most methods were based on the active participation of pupils and included a number of individual activities (e.g., reflection on values, goal setting, self-monitoring [87, 137]) or group activities (e.g., scenario writing [133], analyzing case and proposing a solution [29, 115]). On the other hand, in relatively few interventions, pupils were to remain passive (e.g., listening to a lecture, watching a video [25, 57, 74]). Some interventions were based on both of these forms of involvement [21, 28, 30, 46, 66, 69, 90, 98, 101, 103, 107, 111, 112, 120, 135, 136, 139, 142].

Peers play a crucial role in shaping the health behaviors of children and teenagers: they offer mutual support and serve as a role model and a trusted source of information [127]. This social dynamic was used in educational interventions across countries for over 40 years. A peer-to-peer approach was applied in 54 tested interventions [8, 10, 14–17, 21–23, 26, 28, 29, 31, 32, 46, 48, 55, 57, 58, 61, 62, 80, 81, 85, 86, 90, 92, 93, 95, 98, 99, 102, 106, 110, 112–114, 117, 119, 127, 128, 131, 133, 136, 137, 139, 140], either as a main or complementary teaching strategy. With peer-to-peer method as the main strategy, selected pupils typically participated in training for peer leaders and offered workshops, prepared presentations, or moderated discussions with other pupils [15–17, 31, 55, 57, 58, 62, 80, 81, 93, 95, 114, 117, 127, 136]. As a complementary strategy, the peer-to-peer approach was typically used at the end of the intervention. After going through the educational process, pupils created educational materials and presented them to their younger colleagues [10, 14, 21–23, 26, 46, 56, 61, 85, 90, 92, 119, 133, 137]. In 43 interventions, the teacher's role was central to the teaching process. Teachers structured the lessons, introduced content, proposed tasks, and distributed homework assignments, often according to detailed instructions [12, 13, 18–20, 22–24, 28, 29, 46, 49, 51–53, 60, 65, 67, 68, 77, 78, 80, 82, 85, 88, 90, 92, 97, 98, 101, 102, 104, 106, 112, 117, 120, 124, 125, 128, 130–134]. In every fourth intervention, teacher-centered and peer-to-peer methods were combined [12, 13, 19, 20, 22–24, 46, 53, 65, 67, 80, 85, 90, 92, 96, 117, 120, 125, 128, 131, 133]. Data on the central educator were missing in almost 37 articles.

**Educational materials.** To facilitate the learning process, every fourth of the interventions provided educational materials [7–9, 21, 22, 25, 27, 30, 32, 46, 49, 62, 69, 74, 76, 77, 81, 83, 84, 91, 93, 97, 104, 105, 107, 111, 115, 122, 132, 135, 140, 141], such as student activity books, brochures, fact sheets, activity sheets, handouts. In a number of interventions, audiovisual materials created specifically to support the teaching objectives were provided [20, 74, 90, 115].

In 30% of the interventions, the learning process resulted in pupils creating some artefacts. Some of those creative works served as a souvenir and were supposed to remind pupils of the health issue they were taught about [125, 137]. Other works had additional educational purposes, such as a poster exhibition [23, 28, 29, 31, 32, 47, 73, 77, 83, 86, 107], creating a cartoon about the rational use of medicines [12], shooting a video about the process of making reusable sanitary cloth pads [14], developing an educational website on cancer prevention for children that was posted on the website of the Yale Cancer Center [131]. In some interventions, children prepared and consumed foods with certain nutritional values (e.g., low-fat, high-fiber products [77, 87]) or foods from different cultural contexts [8].

In one in three interventions, computer, internet, or other technological tools were used to support the educational process. The application of teaching methods was typically supported by internet search [11, 13, 22, 50, 60, 66, 73, 75, 97, 100, 102, 103, 105, 108, 115, 122, 131, 132], creating presentations [20, 22, 29, 30, 46, 47, 54, 74, 111, 140], communicating or analyzing social media [7, 8, 11, 13, 17, 20, 30, 31, 108, 122], using applications, both those generally

available, i.e. interactive web-based quiz and those developed for the intervention [12, 88, 91, 99, 102, 106, 110, 115, 118], or computer games [84, 103, 107, 111, 118, 134].

**Teaching context.** Within the model of health promoting schools, introduced by the World Health Organization after the release of the Ottawa Charter during the first International Conference on Health Promotion in Ottawa, Canada, in 1986, the socio-ecological perspective on health education was applied in schools [23]. As a result, a number of educational interventions on health involved activities engaging the whole school community [10, 15, 16, 21, 24, 26, 27, 32, 46, 57, 78, 81, 86, 87, 96, 99, 100, 103, 109, 113, 119, 124, 137, 141, 142] or even a broader local community [45, 63, 66, 69, 89, 93, 102, 103, 112, 116, 131, 133, 141, 143, 145], and not just standard classroom teaching. In some studies, not only was the pupil-teacher relationship explored, but also contacts with other social actors were arranged. Twenty-three interventions engaged pupils' parents and caregivers [23, 27, 28, 30, 32, 46, 48, 52, 59, 72, 77, 78, 87, 93, 94, 97, 102, 111, 113, 115, 119, 126, 128]; 12, external experts and scientists [12, 16, 17, 19, 73, 77, 86, 90, 103, 115, 118, 124, 132, 135]; and 8, other social actors [8, 21, 23, 31, 99, 117, 120, 138] such as school administrators, local leaders, or school nurses. The involvement of parents in some interventions ranged from providing information materials [78] to providing technical support (e.g., parents who were farmers provided soil for planters [126]). Parents were also involved through shared activities [97], or they were offered to participate in classes on communicating personal and family's values about sexuality to teenagers [52, 94, 115, 128], or they received newsletters or magazines with health information, heart-healthy recipes, and hands-on activities to do at home [46, 87, 93].

**Significance of critical thinking.** The stage of eligibility criteria assessment showed that critical thinking was included only in a small proportion of health education interventions for children and adolescents. However, the interventions described in the included publications varied with regards to: 1) the methods applied to develop critical thinking skills; and 2) the extent to which they provided details on the teaching process. Based on the information and additional materials provided in the articles, we used those two parameters to evaluate the significance of critical thinking in the tested interventions on a four-point scale (low, moderate, high, and very high significance) (Table 5).

Most interventions (42 articles, 36%) described only one method addressing critical thinking and failed to provide details of the activities. In these interventions, critical thinking was classified as having a low level of significance. The most common approaches reported by the authors were group discussions or debates [7, 9, 15, 20, 26, 47, 53, 59, 62, 63, 69, 76, 93, 109, 117], Socratic discussions [52, 95], question boxes [94, 124], unspecified decision-making exercises [23–25, 49, 55, 65, 68, 74, 77, 85, 97, 112, 127, 134], or reflection activities [118]. The low significance of critical thinking teaching methods was noted in interventions from all decades.

**Table 5. Significance of critical thinking in educational interventions addressing different health issues.**

Decade of publications	Level of significance of critical thinking			
	low	moderate	high	very high
up to 1990	1	0	2	1
1991–2000	4	3	1	0
2001–2010	16	7	3	5
2011–2020	17	11	9	6
from 2021	4	9	12	3

The number of publications calculated in the rows. The colors indicate a relative number of publications calculated in the rows, with red indicating the highest and blue the lowest number.

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**Table 6. Significance of critical thinking in educational interventions addressing different health issues.**

Health issue	Level of significance of critical thinking			
	low	moderate	high	very high
psychoactive substance use	13	10	7	1
SRH	13	8	7	3
nutrition	8	5	9	5
public health	6	6	3	6
physical activity	7	1	3	2
somatic health	4	1	5	1
mental health	4	3	5	1

The number of publications calculated in the columns. The colors indicate a relative number of publications calculated in the columns, with red indicating the highest and blue the lowest number.

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Critical thinking educational methods were most commonly applied in interventions regarding substance use and SRH (Table 6). Half of the intervention addressing physical activity and more than 40% addressing psychoactive substance use and SRH demonstrated a low significance of critical thinking.

In 21 interventions, more than one method stimulating critical thinking was listed. Critical thinking in these interventions was classified as having moderate significance. However, activities for developing critical thinking skills constituted a small part of a broader educational program or the articles did not provide details suggesting otherwise [12, 17, 21, 29, 48, 50, 54, 57, 60, 75, 82–84, 86, 92, 99, 100, 108, 110, 114, 119, 121, 128, 132, 139, 143, 144]. Apart from discussion or decision-making exercises, these interventions typically involved other methods facilitating critical thinking, such as situational role playing, problem-solving, participation in developing educational activities on health, designing wall magazines, assessing individual or community health resources, analyzing media information, and solving case studies. For about 30% of the interventions addressing psychoactive substance use and SRH teaching critical thinking was of a moderate importance.

The interventions classified as showing a high or very high significance of critical thinking included multiple teaching methods stimulating critical thinking skills and provided a detailed description of the whole educational process, a relationship between the teaching objectives and applied teaching methods, and how they were translated into specific learning activities, materials, and outcomes.

Twenty-seven interventions characterized by high significance of critical thinking [11, 13, 14, 22, 28, 30, 32, 64, 67, 70–73, 80, 89, 98, 102, 105, 106, 111, 113, 120, 122, 123, 126, 131, 140–142] discussed a broader scope of health literacy skills, with critical thinking being only one of those skills. On the other hand, interventions with a very high level of significance [8, 10, 18, 31, 61, 88, 96, 115, 125, 130, 133, 135, 137, 138] were dedicated to critical thinking and comprehensively addressed a set of skills involved. Reporting on educational interventions that approached critical thinking in a more complex manner became more common after 2000. Critical thinking gained more significant coverage in more than half of the interventions focused on nutrition (52%). We observed high or very high significance of critical thinking in interventions teaching about somatic health (46%), physical activity (46%) and public health (45%) (Table 6).

High and very high significance was demonstrated especially for interventions that incorporated problem-solving as opposed to those with practice as the central component. The

**Table 7. Significance of critical thinking in educational interventions intersected with categorization regarding of central teaching component.**

Central teaching component	Level of significance of critical thinking			
	low	moderate	high	very high
practice	23	16	18	8
exposition	16	15	13	10
problem solving	16	12	22	12
factual content	12	11	9	5
mixed	19	16	14	10

The number of publications calculated in the rows. The colors indicate a relative number of publications calculated in the rows, with red indicating the highest and blue the lowest number

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latter interventions were characterized mainly by low significance of methods addressing critical thinking (Table 7).

Examples of the most interesting interventions in which critical thinking had high or very high significance are described in Table 8.

## Discussion

### Summary of the main results

Our scoping review demonstrated a large variety of educational interventions regarding health issues over time and across continents. The interventions reported in the included articles focused mainly on lifestyle-related health issues, which reflect the dynamic changes in the discourse on the health of children and adolescents as well as in the priorities of health prevention programs [145–147]. Healthy lifestyle interventions implemented before 2011 typically aimed at developing knowledge, skills, and/or attitudes related to substance use, SRH, and broader problems of public health. Subsequent interventions seem to reflect the more recent conceptualization of healthy lifestyle in relation to an increase in obesity in children [148], as they additionally cover habits linked to nutrition and physical activity. More specific aspects of individual health, such as particular somatic or mental health disorders, seem to be receiving more attention in health education interventions in 21st century. The regional dynamics of the coverage of health topics, as observed in our review, can be explained by various regional health challenges and local socio-cultural determinants of health.

A similar diversity was noted in the teaching methods applied in the interventions studied over the period of 40 years. While older interventions (before 2001) primarily focused on exposing students to external or internal stimuli, delivering factual content or practical activities to promote health behaviors, the more recent interventions design the educational process around problem-solving tasks. The teaching methods used in the interventions addressing nutrition and physical activity were mostly oriented towards developing practical skills, while those applied in the interventions addressing sexual health or substance use emphasized problem-solving skills. Mixing those various components was a strategy applied in interventions addressing all thematic areas.

In some interventions, the teaching process was accompanied by various types of educational materials, and sometimes pupils created educational artefacts themselves. Most teaching methods used in the studied interventions encouraged pupils to actively participate in the learning process, express their opinions in writing, or develop various types of educational materials. Such approaches facilitate the integration of knowledge, skills, and essential components of attitudes. Some articles tested interventions that engaged peer educators in promoting

**Table 8. Interventions with high and very high level of significance of critical thinking in teaching methods addressing a given health issue.**

Health issue	Teaching methods	Description of the intervention
SRH: HIV/AIDS prevention	Problem solving	Pupils were asked to write a response to a teenager's question about her risk of contracting a sexually transmitted disease from her boyfriend. Small groups of pupils assumed the role of an HIV clinic counsellor. After an in-depth analysis of her situation and identification of her misconceptions about HIV, pupils were supposed to write down information to improve her understanding [133].
SRH	Exposition and problem-solving	<i>If I Were Jack</i> was a relationships and sexuality education program resource that focused on young men and unintended pregnancy. It was based on an interactive video drama that told the story of Jack, a teenager who had just found out that his girlfriend is unexpectedly pregnant. Pupils were encouraged to discuss Jack's situation as well his and his girlfriend's options and decisions. The education program was designed to promote critical thinking about social pressures that normally situated teenage pregnancy and to go beyond the gender stereotypes surrounding teenage pregnancy [115].
Substance-use prevention	Problem-solving	The intervention consisted of three components. In the first component, pupils shared their own beliefs about cigarette smoking and confronted them with the knowledge of their peers as well as expert knowledge. Then, through role-playing, pupils learned to resist pressure (from peers, the media). The third component was about decision-making and commitment, where pupils integrated all of the information and were asked to consider the social consequences of smoking in their own social environment. Each pupil then made a decision of whether to smoke or not, along with providing the main reason. The decision, along with the reasons, was announced in front of classmates [61].
Nutrition	Practical and problem-solving	Pupils debated the fictive cases brought up in the blogs provided by the teacher and applied their evidence-based knowledge to solve the nutritional dilemma presented in the blogs. They explained and argued the kind of guidance they had given to their cases, and then, the whole class discussed the cases and the adequacy of prescribed instructions [11].
	Problem-solving	<i>The shopping bag game</i> involved selecting different foods and justifying the choices made. The children were presented with a selection of different food items, e.g.: vegetables, yoghurt, cheese, and eggs. Each product contained a ticket with information such as the cost of the food, its country of origin, how far it has travelled, and whether it is organic or nonorganic. The children shopped by selecting product tickets. At the end of the game, they had to say what influenced their choice [126].
Physical activity	Practical and problem-solving	The intervention that combined a number of activities, including those directed at assessing one's physical activity and diet and proposing solutions for oneself, others, and the local environment. Among other things, the students used the knowledge they gained in finding solutions and advising their peer, Calvin, from the case study, who would like to return to playing basketball after years of unhealthy lifestyle. They used pedometers to check their activity throughout the day, and analyzed facilities that encourage a sedentary lifestyle. The culmination of the intervention was the development of an artifact that would help their peers, parents, school community or the community at large change their current environment or navigate it to make healthy food and activity choices [96].

(Continued)

Table 8. (Continued)

Health issue	Teaching methods	Description of the intervention
Mental health	Exposition and problem-solving	The intervention included three phases: readiness, instructional, and application. In the readiness skills phase, pupils were trained through role-playing activities to actively listen to others and to self-control. Pupils received positive and/or corrective feedback and were guided to recognize needs and feelings in themselves and others, and to develop a sense of responsibility as a group member. During the instructional phase, pupils developed the steps required for social problem-solving and decision-making and finally trying out the solutions in a safe environment [64].
Somatic health	Problem-solving	During class on respiratory system and health, pupils used their knowledge on research in science and practiced communication skills in expressing agreement or disagreement and considering reasons in favor of the opposite point of view and refute them to wrote an argumentative essay entitled "Do you agree or disagree with the use of images of people smoking on television?" [125].
Public health	Problem-solving, practical, exposition	Learning about Danish and Kenyan food culture in the context of health inequalities, pupils from two countries used letters and online communicators to get to know each other and. They shared their daily experiences and typical food products to understand interdependence between people and nations as well as differences in lifestyle and health behaviours [8].
	Exposition	Individuals with lived experience of violence from the Veterans Education Project shared their stories with pupils, who were then instructed to write a response to open-ended questions for two minutes. The questions were designed to be neutral and to assist students in organizing their thoughts: <i>What was your response to the story? What was the main message of the story? What were the storyteller's attitudes about violence? How did these attitudes change as a result of the storyteller's experiences? What did you like about the story? What did you dislike?</i> Pupils responded in a free writing format [18].

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healthy choices, presenting useful skills, and explaining health information. While most of the available evidence suggests the effectiveness of peer-to-peer teaching in higher education [149, 150], a recent scoping review of studies on peer education in health interventions for adolescents revealed that involving peer-to-peer education may be a promising strategy for health improvement also on lower educational levels [151]. The way of shaping health behaviors in the included interventions focused not only on expanding the knowledge of individual pupils as well as training their health-related skills, but also encompassed the broader social context of pupils: their families, local communities, or intercultural contacts. Moreover, in some interventions, pupils met medical professionals, patients and their caregivers, or external experts and scientists, sometimes in their work setting.

In summary, there is evidence to suggest that peer-to-peer interaction is one of the teaching strategies related to student gains in critical thinking. Therefore, leaving the role of the central educator to pupils and designing interventions that engage pupils in individual and group activities (such as problem solving, developing educational materials or artefacts) are possibly those dimensions of the teaching methods that offer greatest benefits in terms of learning critical thinking skills.

### Importance of critical thinking in health education of children up to high school

The extent to which the included interventions covered critical thinking skills varied widely. This heterogeneity is associated with the year of the publication and the dynamics of

pedagogical discourse. The growing demands of the contemporary information society [22] and changing public health challenges in the past four decades has resulted in a growing appreciation of teaching critical thinking. The increase in the complexity of integrating critical thinking into educational interventions is particularly evident in the publications released from 2021.

### Strengths and limitations

To our best knowledge, this is the first study to comprehensively review the existing literature on the teaching methods for critical thinking in the health education of children up to high school. The review was conducted by an interdisciplinary team and was based on an extensive literature search including all types of research from all continents.

Our review also has some limitations. As our search was performed in 20 September 2023, there is a considerable disproportion in the number of articles between decades, with fewer articles categorized as those published from 2021 as compared with the earlier decades. Moreover, the studies and interventions included in the review were highly heterogenous, and the description of some teaching methods was not satisfactory, limiting possibility to replicate them. Some of the included studies only listed the teaching methods without any additional information. Developing reporting checklist for health education interventions in school context- such as TIDieR checklist [152] available for interventions in general or GREET [153] for evidence-based practice educational interventions, may improve future reporting and replicability of such interventions. Moreover, as we were interested in the educational programs stably functioning in the school setting and engaging school-based actors, we excluded interventions that were implemented only by external educators, external leaders, medical school students, or medical professionals. Future studies should map the methods applied in extracurricular interventions. Finally, we included only articles in English; thus, we potentially missed out on studies published in other languages.

### Conclusions

Our review showed that health education interventions in children and adolescents usually did not address the development of critical thinking skills in a comprehensive manner. Interventions in which critical thinking had high and very high significance applied mainly problem-solving methods and involved pupils' activity. The evidence on the effectiveness of the teaching methods that develop critical thinking skills is limited because most articles failed to provide detailed information on the teaching methods or did not examine their effects. Therefore, to facilitate further research in this field, we recommend that the teaching strategies used in the interventions are described in greater detail and that the effectiveness of individual teaching methods is assessed and reported. The development of a reporting checklist to describe health education interventions is warranted.

### Supporting information

**S1 Table. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.**

(DOCX)

**S2 Table. Search strategies.**

(DOCX)

**S3 Table. Characteristics of the included studies.**

(DOCX)

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## References

1. WHO. Health literacy. The solid facts. Copenhagen, Denmark: World Health Organization 2013.
2. Ishikawa H, Yano E. Patient health literacy and participation in the health-care process. *Health expectations: an international journal of public participation in health care and health policy*. 2008; 11(2):113–22. <https://doi.org/10.1111/j.1369-7625.2008.00497.x> PMID: 18494956
3. Paakkari L. COVID-19: health literacy is an underestimated problem. *The Lancet*. 2020; 5(5): E249–E50. [https://doi.org/10.1016/S2468-2667\(20\)30086-4](https://doi.org/10.1016/S2468-2667(20)30086-4) PMID: 32302535
4. Richard P, Elder L. *Critical Thinking*. London: Rowman & Littlefield; 2020.
5. Aronson JK, Barends E., Boruch R., Brennan M., Chalmers I., Chislett J., et al. Key concepts for making informed choices. *Nature*. 2019; 572(7769):303–6. <https://doi.org/10.1038/d41586-019-02407-9> PMID: 31406318
6. Zarocostas J. How to fight an infodemic. *The Lancet*. 2020; 395(10225):676. [https://doi.org/10.1016/S0140-6736\(20\)30461-X](https://doi.org/10.1016/S0140-6736(20)30461-X) PMID: 32113495
7. Bruselius-Jensen M, Bonde AH, Christensen JH. Promoting health literacy in the classroom. *The Health Education Journal*. 2017; 76(2):156–68. <http://dx.doi.org/10.1177/0017896916653429>.

8. Bruselius-Jensen M, Renwick K, Aagaard-Hansen J. Cross-cultural school-based encounters as global health education. *The Health Education Journal*. 2017; 76(3):349–61. <http://dx.doi.org/10.1177/0017896916676209>.
9. Bruselius-Jensen ML, Danielsen D, Ane Kirstine Viller H. Pedometers and participatory school-based health education—an exploratory study. *Health Education*. 2014; 114(6):487–500. <http://dx.doi.org/10.1108/HE-12-2013-0064>.
10. Kafewo SA. Using drama for school-based adolescent sexuality education in Zaria, Nigeria. *Reproductive Health Matters*. 2008; 16(31):202–10. [https://doi.org/10.1016/S0968-8080\(08\)31356-1](https://doi.org/10.1016/S0968-8080(08)31356-1) PMID: 18513621
11. Kärkkäinen S, Hartikainen-Ahia A, Elorinne A-L, Hokkanen J, Hämeen-Anttila K. Adolescents' learning and experiences of solving the need for dietary supplementation through socioscientific issue (SSI) method. *Health Education*. 2019; 119(2):165–76. <http://dx.doi.org/10.1108/HE-01-2019-0002>.
12. Karkkainen S, Kukkonen J, Kontturi S, Keinonen T. Promoting health literacy: sixth graders working in partnership with the local pharmacy. *Health Education*. 2018; 118(6):470–82. <https://doi.org/10.1108/HE-01-2018-0004> WOS:000450206000002.
13. Fage-Butler AM. Challenging violence against women: a Scottish critical health literacy initiative. *Health promotion international*. 2019; 34(6):1097–105. <https://doi.org/10.1093/heapro/day067> Language: English. Entry Date: 20191220. Revision Date: 20201130. Publication Type: Article. PMID: 30203038
14. Ghimire S, Devkota B. Participatory video on menstrual hygiene: A skills-based health education approach for adolescents in nepal. *Adolescent Health, Medicine and Therapeutics*. 2020; 11:119–22. <https://doi.org/10.2147/AHMT.S262135> PMID: 32982531
15. Pieczka M, Casteltrione I. AlcoLOLs, re-thinking drinking: Developing a shared leadership approach for alcohol education. *Health Education Journal*. 2020; 79(3):346–61. <https://doi.org/10.1177/0017896919883364>
16. Shah S, Foley BC, Molinari I, Lim K-S, Shrewsbury VA. The Students As LifeStyle Activists (SALSA) program. *British Journal of Sports Medicine*. 2017; 51(19):1445. <https://doi.org/10.1136/bjsports-2016-097219> PMID: 28583995
17. Shah S, van der Sluijs CP, Lagleva M, Pesle A, Lim KS, Bittar H, et al. A partnership for health: Working with schools to promote healthy lifestyle. *Australian family physician*. 2011; 40(12):1011–3. PMID: 22146334
18. Werle GD. The lived experience of violence: using storytelling as a teaching tool with middle school students. *The Journal of school nursing: the official publication of the National Association of School Nurses*. 2004; 20(2):81–7. <https://doi.org/10.1177/10598405040200020501> PMID: 15040767
19. Brotman JS, Mensah FM. Urban high school students' perspectives about sexual health decision-making: the role of school culture and identity. *Cultural Studies of Science Education*. 2013; 8(2):403–31. <https://doi.org/10.1007/s11422-012-9451-x> WOS:000214444400012.
20. Briñez DKR, Panqueva ÁHG, Hinojos IAF. How Should I Teach Sex Education in Middle School? An Action Research Study on an ICT-Based Intervention. *The Qualitative Report*. 2019; 24(2):405–28.
21. Pacheco M, Adelsheim S, Davis L, Mancha V, Aime L, Nelson P, et al. Innovation, peer teaching, and multidisciplinary collaboration: outreach from a school-based clinic. *The Journal of School Health*. 1991; 61(8):367–9. <https://doi.org/10.1111/j.1746-1561.1991.tb07420.x> PMID: 1787703
22. Nygard T, Hirvonen N, Raisanen S, Korkeamaki RL. Ask Your Mother! Teachers' Informational Authority Roles in Information-seeking and Evaluation Tasks in Health Education Lessons. *Scandinavian Journal of Educational Research*. 2021; 65(6):972–85. <https://doi.org/10.1080/00313831.2020.1788145> WOS:000547731500001.
23. Ridge D, Northfield J, St. Leger L, Marshall B, Sheehan M, Maher S. Finding a Place for Health in the Schooling Process: A Challenge for Education. *Australian Journal of Education*. 2002; 46(1):19–33.
24. Ruge D, Nielsen MK, Mikkelsen BE, Bruun-Jensen B. Examining participation in relation to students' development of health-related action competence in a school food setting LOMA case study. *Health Education*. 2016; 116(1):69–85. <https://doi.org/10.1108/HE-08-2014-0087> WOS:000369991900005.
25. Begoray DL, Wharf-Higgins J, Macdonald M. High school health curriculum and health literacy: Canadian student voices. *Global Health Promotion*. 2009; 16(4):35–42. <https://doi.org/10.1177/1757975909348101> PMID: 20028667
26. Bell RM, Ellickson PL, Harrison ER. Do drug prevention effects persist into high school? How project ALERT did with ninth graders. *Preventive medicine*. 1993; 22(4):463–83. <https://doi.org/10.1006/pmed.1993.1038> PMID: 8415497
27. Wang H, Zhou Y, Blake H, Chattopadhyay K. School-Based Physical Activity Intervention: A Qualitative Process Evaluation of a Feasibility Trial in Yangzhou, China. *International Journal of*

- Environmental Research and Public Health. 2022; 19(2):1021. <https://doi.org/10.3390/ijerph19021021> PMID: 35055842
28. Ponsford R, Meiksin R, Bragg S, Crichton J, Emmerson L, Tancred T, et al. Co-production of two whole-school sexual health interventions for English secondary schools: positive choices and project respect. *Pilot and Feasibility Studies*. 2021; 7:1–17. <https://doi.org/10.1186/s40814-020-00752-5>.
  29. Manesis N, Chatzidaki N, Gialamas M. Applying De Bono's Six Thinking Hats for an Anti-Bullying Program. 2022; 16(4):440–7.
  30. Marshman Z, El-Yousfi S, Kellar I, Dey D, Robertson M, Day P, et al. Development of a secondary school-based digital behaviour change intervention to improve tooth brushing. *BMC Oral Health*. 2021; 21:1–9. <https://doi.org/10.1186/s12903-021-01907-3>.
  31. Jones N, Cohen J, Chapman JI. Empowering High School Students to Address Racial Disparities During the COVID-19 Pandemic. *Pediatrics*. 2022; 149(1):1–4. <https://doi.org/10.1542/peds.2021-050483> PMID: 34904155
  32. Arauz Ledezma AB, Massar K, Kok G. Social Emotional Learning and the promotion of equal personal relationships among adolescents in Panama: a study protocol. *Health promotion international*. 2021; 36(3):741–52. <https://doi.org/10.1093/heapro/daaa114> PMID: 33051640
  33. Machete P, Turpin M. The Use of Critical Thinking to Identify Fake News: A Systematic Literature Review. In: Hattingh M, Matthee M., Smuts H., Pappas I., Dwivedi Y.K., Mäntymäki M., editor. *Lecture Notes in Computer Science 12067*: Springer Cham; 2020. p. 235–46.
  34. Hansen W. Lee SMK. *Improving Classroom Discussion in Economics Courses*. The International Handbook on Teaching and Learning Economics: Edward Elgar Publishing; 2011.
  35. Pithers R, Soden R. Critical Thinking in Education: A Review. *Educational Research*. 42:237–49.
  36. Yang Y-TC, Newby TJ, Bill RL. Using Socratic Questioning to Promote Critical Thinking Skills Through Asynchronous Discussion Forums in Distance Learning Environments. *American Journal of Distance Education*. 2005; 19(3):163–81. [https://doi.org/10.1207/s15389286ajde1903\\_4](https://doi.org/10.1207/s15389286ajde1903_4)
  37. Hu Z. Promoting Critical Thinking through Socratic Questions in Health Sciences Work-Integrated Learning. *International Journal of Learning, Teaching and Educational Research*. 2022; 22(5). <https://doi.org/10.26803/ijlter.22.6.8>.
  38. Stigmar M. Peer-to-peer Teaching in Higher Education: A Critical Literature Review. *Mentoring & Tutoring: Partnership in Learning*. 2016; 24(2):124–36. <https://doi.org/10.1080/13611267.2016.1178963>
  39. Aromataris E, Munn Z. *JBI Manual for Evidence Synthesis*: JBI; 2020. Available from: <https://synthesismanual.jbi.globa>.
  40. Tricco AC, Lillie E., Zarin W., O'Brien K. K., Colquhoun H., Levac D., et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of internal medicine*. 2018; 169(7):467–73. <https://doi.org/10.7326/M18-0850> PMID: 30178033
  41. Światkiewicz-Mośny M, Ślusarczyk M, Prokop-Dorner A, Piłat-Kobla A, Potysz-Rzyman A, Oze-galska-Lukasik N, et al. Teaching methods for critical thinking in health education in children up to high school. *OSF*. 2022. <https://doi.org/10.17605/OSF.IO/46TEZ>
  42. Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med Res Meth*. 2008; 8(45). <https://doi.org/10.1186/1471-2288-8-45> PMID: 18616818
  43. Darling S, Dawson G, Quach J, Smith R, Perkins A, Connolly A, et al. Mental health and wellbeing coordinators in primary schools to support student mental health: protocol for a quasi-experimental cluster study. *BMC Public Health*. 2021; 21:1–14. <http://dx.doi.org/10.1186/s12889-021-11467-4>.
  44. Martinez Garcia L, Samsó Jofra L, Alonso-Coello P, Ansuategi E, Asso Mistral L, Ballesteros M, et al. Teaching and learning how to make informed health choices: Protocol for a context analysis in Spanish primary schools. *F1000Research*. 2021; 10:312. <https://dx.doi.org/10.12688/f1000research.51961.2>.
  45. Sánchez-Miguel PA, Vaquero-Solís M, Sánchez-Oliva D, Pulido JJ, López-Gajardo MA, Tapia-Serrano MA. Promoting Healthy Lifestyle through Basic Psychological Needs in Inactive Adolescents: A Protocol Study from Self-Determination Approach. *Sustainability*. 2020; 12(15):5893. <http://dx.doi.org/10.3390/su12155893>.
  46. Anderson AS, Porteous LEG, Foster E, Higgins C, Stead M, Hetherington M, et al. The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables. *Public Health Nutrition*. 2005; 8(6):650–6. <https://doi.org/10.1079/phn2004721> PMID: 16236195
  47. Araújo J, Gomes CC, Jácomo A, Pereira SM. Teaching bioethics in high schools. *Health Education Journal*. 2017; 76:507–13. <https://doi.org/10.1177/0017896917690566> Language: English. Entry Date: Revision Date: 20171103. Publication Type: Article.



48. Caria MP, Faggiano F, Bellocco R, Galanti MR, Group EU DS, Siliquini R ZBCLV-TFVSVLBKvdKPMJCVLWG. Effects of a school-based prevention program on European adolescents' patterns of alcohol use. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*. 2011; 48(2):182–8. <https://doi.org/10.1016/j.jadohealth.2010.06.003> PMID: 21257118
49. Denny G, Young M. An evaluation of an abstinence-only sex education curriculum: an 18-month follow-up. *Journal of School Health*. 2006; 76(8):414–22. <https://doi.org/10.1111/j.1746-1561.2006.00135.x> Language: English. Entry Date: Revision Date: 20200708. Publication Type: Journal Article.
50. Gonzales R, Glik D, Davoudi M, Ang A. Media Literacy and Public Health: Integrating Theory, Research, and Practice for Tobacco Control: PROD. *The American Behavioral Scientist*. 2004; 48(2):189–201.
51. Hanewinkel R, Aßhauer M. Fifteen-month follow-up results of a school-based life-skills approach to smoking prevention. *Health education research*. 2004; 19(2):125–37. <https://doi.org/10.1093/her/cyg018> PMID: 15031272
52. Giles SM, Harrington NG, Fearnow-Kenney M. Evaluation of the All Stars program: Student and teacher factors that influence mediators of substance use. *Journal of Drug Education*. 2001; 31(4):385–97. <https://doi.org/10.2190/GGVY-Y4AK-EPB0-0MQ5> PMID: 11957393
53. Giles SM, Pankratz MM, Ringwalt C, Hansen WB, Dusenbury L, Jackson-Newsom J. Teachers' delivery skills and substance use prevention program outcomes: the moderating role of students' need for cognition and impulse decision making. *Journal of Drug Education*. 2010; 40(4):395–410. <https://doi.org/10.2190/DE.40.4.e> PMID: 21381465
54. Tiwari P, Naik PR, Nirgude AS, Datta A. Effectiveness of life skills health education program: A quasi-experimental study among school students of South India. *Journal of Education and Health Promotion*. 2020; 9(1). [https://doi.org/10.4103/jehp.jehp\\_564\\_20](https://doi.org/10.4103/jehp.jehp_564_20) WOS:000610543200007. PMID: 33575372
55. Timol F, Vawda MY, Bhana A, Moolman B, Makoe M, Swartz S. Addressing adolescents' risk and protective factors related to risky behaviours: Findings from a school-based peer-education evaluation in the Western Cape. *SAHARA J: journal of Social Aspects of HIV/AIDS Research Alliance*. 2016; 13(1):197–207. <https://doi.org/10.1080/17290376.2016.1241188> PMID: 27892820
56. Shinde S, Weiss HA, Khandeparkar P, Pereira B, Sharma A, Gupta R, et al. A multicomponent secondary school health promotion intervention and adolescent health: An extension of the SEHER cluster randomised controlled trial in Bihar, India. *PLoS Medicine*. 2020; 17(2). <https://doi.org/10.1371/JOURNAL.PMED.1003021> PMID: 32045409
57. Kelder SH, Perry CL, Lytle LA, Klepp KI. Community-wide youth nutrition education: Long-term outcomes of the Minnesota Heart Health Program. *Health education research*. 1995; 10(2):119–31. <https://doi.org/10.1093/her/10.2.119-a> PMID: 10160226
58. Perry CL, Klepp KI, Sillers C. Community-wide strategies for cardiovascular health: the Minnesota Heart Health Program youth program. *Health education research*. 1989; 4(1):87–101.
59. Dinaj-Koci V, Chen X, Deveaux L, Lunn S, Li X, Wang B, et al. Developmental Implications of HIV Prevention during Adolescence: Examination of the Long-Term Impact of HIV Prevention Interventions Delivered in Randomized Controlled Trials in Grade Six and in Grade 10. *Youth & Society*. 2015; 47(2):151–72.
60. Dunton GF, Liao Y, Grana R, Lagloire R, Riggs N, Chou C-P, et al. State-wide dissemination of a school-based nutrition education programme: a RE-AIM (Reach, Efficacy, Adoption, Implementation, Maintenance) analysis. *Public Health Nutrition*. 2014; 17(2):422–30. <https://doi.org/10.1017/S1368980012005186> PMID: 23218458
61. Flay BR, Ryan KB, Best JA. Are social-psychological smoking prevention programs effective? The Waterloo study. *Journal of Behavioral Medicine*. 1985; 8(1):37–59. <https://doi.org/10.1007/BF00845511> PMID: 3981627
62. Mason-Jones AJ, Mathews C, Flisher AJ. Can peer education make a difference? Evaluation of a South African adolescent peer education program to promote sexual and reproductive health. *AIDS and Behavior*. 2011; 15(8):1605–11. <https://doi.org/10.1007/s10461-011-0012-1> PMID: 21809049
63. Palmer SE, Bycura DK, Warren M. A Physical Education Intervention Effects on Correlates of Physical Activity and Motivation. *Health Promotion Practice*. 2018; 19(3):455–64. <https://doi.org/10.1177/1524839917707740> PMID: 28548556
64. Hassan KE, Mouganie Z. Implementation of the Social Decision-Making Skills Curriculum on primary students (Grades 1–3) in Lebanon. *School Psychology International*. 2014; 35(2):167–75. <https://doi.org/10.1177/0143034312469758> Language: English. Entry Date: 20140326. Revision Date: 20170203. Publication Type: Article.

65. Hecht ML, Graham JW, Elek E. The drug resistance strategies intervention: Program effects on substance use. *Health Communication*. 2006; 20(3):267–76. [https://doi.org/10.1207/s15327027hc2003\\_6](https://doi.org/10.1207/s15327027hc2003_6) PMID: 17137418
66. Jacque BP, Koch-Weser SS, Faux RP, Meiri KP. Addressing Health Literacy Challenges With a Cutting-Edge Infectious Disease Curriculum for the High School Biology Classroom. *Health Education and Behavior*. 2016; 43(1):43. <https://doi.org/10.1177/1090198115596163> PMID: 26194205
67. Johnson CA, Hansen WB, Collins LM, Graham JW. High-school smoking prevention: Results of a three-year longitudinal study. *Journal of Behavioral Medicine*. 1986; 9(5):439–52. <https://doi.org/10.1007/BF00845132> PMID: 3795263
68. Moreira P, Crusellas L, Sá I, Gomes P, Matias C. Evaluation of a manual-based programme for the promotion of social and emotional skills in elementary school children: results from a 4-year study in Portugal. *Health promotion international*. 2010; 25(3):309–17. <https://doi.org/10.1093/heapro/daq029> Language: English. Entry Date: PMID: 20418389. Revision Date: 20200708. Publication Type: Journal Article.
69. Neumann CM, Bloomfield MM, Harding AK, Sherburne H. An Innovative Approach To Teaching High School Students about Indoor Air Quality. *Journal of Environmental Health*. 1999; 62(4):9–13.
70. Midford R, Cahill H, Lester L, Foxcroft DR, Ramsden R, Venning L. Smoking Prevention for Students: Findings From a Three-Year Program of Integrated Harm Minimization School Drug Education. *Substance use & misuse*. 2016; 51(3):395–407. <https://doi.org/10.3109/10826084.2015.1110173> PMID: 26886503
71. Midford R, Mitchell J, Lester L, Cahill H, Foxcroft D, Ramsden R, et al. Preventing alcohol harm: Early results from a cluster randomised, controlled trial in Victoria, Australia of comprehensive harm minimisation school drug education. *International Journal of Drug Policy*. 2014; 25(1):142–50. <https://doi.org/10.1016/j.drugpo.2013.05.012> PMID: 23867047
72. Midford R, Ramsden R, Lester L, Cahill H, Mitchell J, Foxcroft DR, et al. Alcohol Prevention and School Students: Findings From an Australian 2-Year Trial of Integrated Harm Minimization School Drug Education. *Journal of Drug Education*. 2014; 44(3–4):71–94. <https://doi.org/10.1177/0047237915579886> PMID: 25852045
73. Moreno NP, Newell AD, Zientek LR, Nimon K, Vogt GL. Linking science education and HIV using viral biology, epidemiology and science practices. *Health Education Journal*. 2018; 77(8):884–98. <https://doi.org/10.1177/0017896918783778>
74. Seal N. Preventing tobacco and drug use among Thai high school students through life skills training. *Nursing & health sciences*. 2006; 8(3):164–8. <https://doi.org/10.1111/j.1442-2018.2006.00275.x> PMID: 16911176
75. Shensa A, Phelps-Tschang J, Miller E, Primack BA. A randomized crossover study of web-based media literacy to prevent smoking. *Health education research*. 2016; 31(1):48–59. <https://doi.org/10.1093/her/cyv062> PMID: 26675176
76. Velasco V, Griffin KW, Botvin GJ, Celata C, Antichi M, Mercuri F, et al. Preventing Adolescent Substance Use Through an Evidence-Based Program: Effects of the Italian Adaptation of Life Skills Training. *Prevention Science*. 2017; 18(4):394–405. <https://doi.org/10.1007/s11121-017-0776-2> PMID: 28353126
77. Venditti EM, Elliot DL, Faith MS, Firrell LS, Giles CM, Goldberg L, et al. Rationale, design and methods of the HEALTHY study behavior intervention component. *International Journal of Obesity*. 2009; 33: S44–S51. <https://doi.org/10.1038/ijo.2009.116> WOS:000269638600006. PMID: 19623189
78. Wolfe DA, Crooks C, Jaffe P, Chiodo D, Hughes R, Ellis W, et al. A school-based program to prevent adolescent dating violence: A cluster randomized trial. *Archives of Pediatrics and Adolescent Medicine*. 2009; 163(8):692–9. <https://doi.org/10.1001/archpediatrics.2009.69> PMID: 19652099
79. Wolfe DA, Crooks CV, Chiodo D, Hughes R, Ellis W. Observations of Adolescent Peer Resistance Skills Following a Classroom-Based Healthy Relationship Program: A Post-intervention Comparison. *Prevention Science*. 2012; 13(2):196–205. <https://doi.org/10.1007/s11121-011-0256-z> PMID: 22057307
80. Wiist WH, Snider G. Peer education in friendship cliques: Prevention of adolescent smoking. *Health education research*. 1991; 6(1):101–8. <https://doi.org/10.1093/her/6.1.101> PMID: 14719519
81. Bond L, Thomas L, Coffey C, Glover S, Butler H, Carlin JB, et al. Long-term impact of the Gatehouse Project on cannabis use of 16-year-olds in Australia. *The Journal of School Health*. 2004; 74(1):23–9. <https://doi.org/10.1111/j.1746-1561.2004.tb06597.x> PMID: 15022372
82. Borawski EA, Trapl ES, Adams-Tufts K, Hayman LL, Goodwin MA, Lovegreen LD. Taking Be Proud! Be Responsible! to the Suburbs: A Replication Study. *Perspectives on Sexual and Reproductive Health*. 2009; 41(1):12–22. <https://doi.org/10.1111/j.1931-2393.2009.4111209.x> PMID: 19291124.

83. Kupersmidt JB, Scull TM, Austin EW. Media literacy education for elementary school substance use prevention: Study of media detective. *Pediatrics*. 2010; 126(3):525–31. <https://doi.org/10.1542/peds.2010-0068> PMID: 20732940
84. Lin LC, Huang CM, Hsu HP, Liao JY, Lin CY, Guo JL. Integrating health literacy into a theory-based drug-use prevention program: a quasi-experimental study among junior high students in Taiwan. *BMC Public Health*. 2021; 21(1):1768. <https://doi.org/10.1186/s12889-021-11830-5> PMID: 34583659
85. Orsini MM, Wyrick DL, Hansen WB, Rita GOS, Hallfors D, Steckler AB, et al. Evaluation of an infused alcohol and drug prevention programme. *Health Education*. 2019; 119(3):230–43. <http://dx.doi.org/10.1108/HE-07-2018-0035>.
86. O'Hara P, et al. A Peer-Led AIDS Prevention Program for Students in an Alternative School. *Journal of School Health*. 1996; 66(5):176–82. EJ533456. <https://doi.org/10.1111/j.1746-1561.1996.tb06271.x> PMID: 8735582
87. Resnicow K, Cross D, Wynder E. The Know Your Body program: A review of evaluation studies. *Bulletin of the New York Academy of Medicine: Journal of Urban Health*. 1993; 70(2):188–207.
88. Reubsaet A, Brug J, Nijkamp MD, Candel MJJM, van Hooff JP, van den Borne HW. The impact of an organ donation registration information program for high school students in the Netherlands. *Social science & medicine (1982)*. 2005; 60(7):1479–86. <https://doi.org/10.1016/j.socscimed.2004.07.014> PMID: 15652681
89. Riggs NR, Sakuma K-LK, Pentz MA. Preventing risk for obesity by promoting self-regulation and decision-making skills: pilot results from the PATHWAYS to health program (PATHWAYS). *Evaluation review*. 2007; 31(3):287–310. <https://doi.org/10.1177/0193841X06297243> PMID: 17478630
90. King KA, Vidourek RA, Love J, Wegley S, Alles-White M. Teaching adolescents safe driving and passenger behaviors: effectiveness of the You Hold the Key Teen Driving Countermeasure. *Journal of safety research*. 2008; 39(1):19–24. <https://doi.org/10.1016/j.jsr.2007.10.006> PMID: 18325412
91. Kocken PL, van Kesteren NM, Buijs G, Snel J, Dusseldorp E. Students' beliefs and behaviour regarding low-calorie beverages, sweets or snacks: are they affected by lessons on healthy food and by changes to school vending machines? *Public Health Nutrition*. 2015; 18(9):1545–53. <https://doi.org/10.1017/S1368980014002985> PMID: 25591446
92. Bell ML, Kelley-Baker T, Rider R, Ringwalt C. Protecting You/Protecting Me: effects of an alcohol prevention and vehicle safety program on elementary students. *Journal of School Health*. 2005; 75(5):171–7. <https://doi.org/10.1111/j.1746-1561.2005.tb06667.x> Language: English. Entry Date: PMID: 15989086. Revision Date: 20200624. Publication Type: Journal Article.
93. Basen-Engquist K, Parcel GS, Harrist R, Kirby D, Coyle K, Banspach S, et al. The Safer Choices Project: Methodological Issues in School-Based Health Promotion Intervention Research. *Journal of School Health*. 1997; 67(9):365–71. EJ560238. <https://doi.org/10.1111/j.1746-1561.1997.tb07176.x> PMID: 9471087
94. Byers ES, Sears HA, Voyer SD, Thurlow JL, Cohen JN, Weaver AD. An adolescent perspective on sexual health education at school and at home: I. High school students. *Canadian Journal of Human Sexuality*. 2003; 12(1):1–17.
95. Carolan BV, Unger JB, Johnson CA, Valente TW. Ties That Work: The Interaction between Group Assignment Method and a Culturally-Relevant Curriculum in the Context of Middle School Anti-Tobacco Program. *International Electronic Journal of Health Education*. 2007; 10:160–70.
96. Contento IR, Koch PA, Lee H, Sauberli W, Calabrese-Barton A. Enhancing personal agency and competence in eating and moving: formative evaluation of a middle school curriculum—Choice, Control, and Change. *Journal of nutrition education and behavior*. 2007; 39(5 Suppl):S179–86. <https://doi.org/10.1016/j.jneb.2007.02.006> PMID: 17826699
97. Santos-Beneit G, Bodega P, de Miguel M, Rodríguez C, Carral V, Orrit X, et al. Rationale and design of the SI! Program for health promotion in elementary students aged 6 to 11 years: A cluster randomized trial. *The American Heart Journal*. 2019; 210:9–17. <https://doi.org/10.1016/j.ahj.2018.12.011> PMID: 30716509
98. Allsop Y, Anderman EM. Developing Sexual Self-Efficacy Beliefs During Adolescence: Do Health Teachers Really Matter? *Journal of Youth and Adolescence*. 2022; 51(11):2061–76. <https://doi.org/10.1007/s10964-022-01646-w> PMID: 35794443
99. Bonnesen CT, Lau Caspar T, Rod NH, Toftager M, Katrine Rich M, Jensen MP, et al. Preventing Stress among High School Students in Denmark through the Multicomponent Healthy High School Intervention—The Effectiveness at First Follow-Up. *International Journal of Environmental Research and Public Health*. 2023; 20(3):1754. <https://doi.org/10.3390/ijerph20031754> PMID: 36767122
100. Heo MP, Martin SNMPH, Tunzi NBS, Zaret EMPH, Wylie-Rosett JE. School-based HealthyMe Curricula on Health Behaviors and Weight. *Health Behavior and Policy Review*. 2021; 8(5):438–50. <https://doi.org/10.14485/HBPR.8.5.5>.

101. Cooper E, Chen G, Godsell S, Verlander NQ, Thacker A, Eley CV, et al. Improving infection prevention behaviours in schools: Feasibility study to measure the impact of educational resources. *The Health Education Journal*. 2022; 81(7):793–806. <https://doi.org/10.1177/00178969221119933>.
102. Davies C, Marshall HS, Brotherton JML, McCaffery K, Kang M, Macartney K, et al. Complex intervention to promote human papillomavirus (HPV) vaccine uptake in school settings: A cluster-randomized trial. *Preventive Medicine*. 2023; 172((Davies C., [Cristyn.Davies@sydney.edu.au](mailto:Cristyn.Davies@sydney.edu.au); Macartney K.; Skinner S.R.) Specialty of Child and Adolescent Health, Faculty of Medicine and Health, The University of Sydney, NSW, Australia(Davies C., [Cristyn.Davies@sydney.edu.au](mailto:Cristyn.Davies@sydney.edu.au)) Sydney Infectious Diseases In). <https://doi.org/10.1016/j.ypmed.2023.107542> PMID: 37172767
103. de la Fuente-Anuncibay R, Sapio N, Ortega-Sánchez D, Cuesta Gómez JL. Edutainment, Gamification and Nutritional Education: An Analysis of Its Relationship with the Perception of Organizational Culture in Primary Education. 2023; 13(1).
104. Klim-Conforti P, Zaheer R, Levitt AJ, Cheung AH, Schaffer A, Fefergard M, et al. The impact of a children's literature-based cognitive behavioural therapy skills curriculum on middle-school youth who self-report clinically relevant and non-clinical mental health symptomatology. *Journal of Affective Disorders Reports*. 2023; 12((Klim-Conforti P., [paula.klim@mail.utoronto.ca](mailto:paula.klim@mail.utoronto.ca)) Member of the College of Psychologists of Ontario, Toronto, ON, Canada(Klim-Conforti P., [paula.klim@mail.utoronto.ca](mailto:paula.klim@mail.utoronto.ca)) Institute of Medical Science, Faculty of Medicine, University of Toronto, ON, Canada(Zahe). <https://doi.org/10.1016/j.jadr.2023.100471>
105. König L, Marbach-Breittrück E, Engler A, Suhr R. The Development and Evaluation of an e-Learning Course That Promotes Digital Health Literacy in School-age Children: Pre-Post Measurement Study. *Journal of medical Internet research*. 2022; 24(5):e37523. <https://doi.org/10.2196/37523> PMID: 35576572
106. Mesman M, Onrust S, Verkerk R, Hendriks H, Bas Van den P. Effectiveness of the InCharge Prevention Program to Promote Healthier Lifestyles: Protocol for a Randomized Controlled Trial. *JMIR Research Protocols*. 2020; 9(7). <https://doi.org/10.2196/17702> PMID: 32673278
107. Porcu F, Cantacessi C, Dessì G, Sini MF, Ahmed F, Cavallo L, et al. 'Fight the parasite': raising awareness of cystic echinococcosis in primary school children in endemic countries. *Parasites & Vectors*. 2022; 15:1–9. <https://doi.org/10.1186/s13071-022-05575-2> PMID: 36461072
108. Scull TM, Dodson CV, Geller JG, Reeder LC, Stump KN. A Media Literacy Education Approach to High School Sexual Health Education: Immediate Effects of Media Aware on Adolescents' Media, Sexual Health, and Communication Outcomes. *Journal of Youth and Adolescence*. 2022; 51(4):708–23. <https://doi.org/10.1007/s10964-021-01567-0> PMID: 35113295
109. Simon P, Egele VS, Stark R. Impact of intersectoral health and education training on school learning outcomes and emotions. *The Health Education Journal*. 2022; 81(6):768–77. <https://doi.org/10.1177/00178969221114585>.
110. Türkylmaz S, Esen S, Küçükaydın MA, Esen STS. The Effect of Digital Stories about Healthy Eating on Health Behaviors of Primary School Children. *Journal of Education and Future*. 2022;(22):69–83. <https://doi.org/10.30786/jef.990469>.
111. Williams C, Griffin KW, Botvin CM, Sousa S, Botvin GJ. Effectiveness of Digital Health Tools to Prevent Bullying among Middle School Students. *Adolescents* (2673–7051). 2023; 3(1):110–30. <https://doi.org/10.3390/adolescents3010009>
112. Yoon S, Shinki A, Noh DH, Le Thanh T, Lee J. Effects of health education on adolescents' non-cognitive skills, life satisfaction and aspirations, and health-related quality of life: A cluster-randomized controlled trial in Vietnam. *PLoS One*. 2021; 16(12). <https://doi.org/10.1371/journal.pone.0259000> PMID: 34851980
113. Simões C, Santos AC, Lebre P, Daniel JR, Branquinho C, Gaspar T, et al. Assessing the Impact of the European Resilience Curriculum in Preschool, Early and Late Primary School Children. 2021; 42(5):539–66.
114. Audrey S, Holliday J, Parry-Langdon N, Campbell R. Meeting the challenges of implementing process evaluation within randomized controlled trials: The example of ASSIST (A Stop Smoking in Schools Trial). *Health education research*. 2006; 21(3):366–77. <https://doi.org/10.1093/her/cyl029> PMID: 16740670
115. Aventin Á, Gough A, McShane T, Gillespie K, O'Hare L, Young H, et al. Engaging parents in digital sexual and reproductive health education: Evidence from the JACK trial. *Reproductive Health*. 2020; 17(1). <https://doi.org/10.1186/s12978-020-00975-y> PMID: 32854734
116. Cheng Y, Lou CH, Mueller LM, Zhao SL, Yang JH, Tu XW, et al. Effectiveness of a School-Based AIDS Education Program among Rural Students in HIV High Epidemic Area of China. *Journal of Adolescent Health*. 2008; 42(2):184–91. <https://doi.org/10.1016/j.jadohealth.2007.07.016> PMID: 18207097

117. DiCicco L, Biron R, Carifio J, Deutsch C, Mills DJ, Orenstein A, et al. Evaluation of the CASPAR alcohol education curriculum. *Journal of studies on alcohol*. 1984; 45(2):160–9. <https://doi.org/10.15288/jsa.1984.45.160> PMID: 6727377
118. Haruna H, Hu X, Chu SKW, Mellecker RR, Gabriel G, Ndekao PS. Improving sexual health education programs for adolescent students through game-based learning and gamification. *International Journal of Environmental Research and Public Health*. 2018; 15(9). <https://doi.org/10.3390/ijerph15092027> PMID: 30227642
119. Shinde S, Pereira B, Khandeparkar P, Sharma A, Patton G, Ross DA, et al. The development and pilot testing of a multicomponent health promotion intervention (SEHER) for secondary schools in Bihar, India. *Global Health Action*. 2017; 10(1). <https://doi.org/10.1080/16549716.2017.1385284> PMID: 29115194
120. Kapp L, Taylor BA, Edwards LE. Teaching human sexuality in junior high school: an interdisciplinary approach. *The Journal of School Health*. 1980; 50(2):80–3. <https://doi.org/10.1111/j.1746-1561.1980.tb03898.x> PMID: 6898265
121. Paul A, Lim A, Salleh SM, Shahrill M. Enhanced Learning through Analogy in the Teaching of Cardiovascular System. *Journal of Turkish Science Education*. 2019; 16(2):176–86.
122. Petrie M. Young people and alcohol—where's the risk? Changing the focus of school-based prevention initiatives. *Cambridge Journal of Education*. 2017; 47(3):373–87. <http://dx.doi.org/10.1080/0305764X.2016.1176990>.
123. Rajan S, Roberts KJ, Guerra L, Pirsch M, Morrell E. Integrating Health Education in Core Curriculum Classrooms: Successes, Challenges, and Implications for Urban Middle Schools. *The Journal of School Health*. 2017; 87(12):949–57. <https://doi.org/10.1111/josh.12563> PMID: 29096407
124. Maticka-Tyndale E, Wildish J, Gichuru M. Thirty-Month Quasi-Experimental Evaluation Follow-Up of a National Primary School HIV Intervention in Kenya. *Sex Education: Sexuality, Society and Learning*. 2010; 10(2):113–30.
125. Vieira RM, Tenreiro-Vieira C. Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. *International Journal of Science and Mathematics Education*. 2016; 14(4):659–80.
126. Lakin L, Littledyke M. Health promoting schools: integrated practices to develop critical thinking and healthy lifestyles through farming, growing and healthy eating. *International Journal of Consumer Studies*. 2008; 32(3):253–9. <http://dx.doi.org/10.1111/j.1470-6431.2007.00658.x>.
127. Layzer C, Rosapen L, Barr S. Student Voices: Perspectives on Peer-to-Peer Sexual Health Education. *The Journal of School Health*. 2017; 87(7):513–23. <https://doi.org/10.1111/josh.12519> PMID: 28580671
128. Marques M, Ressa N. The Sexuality Education Initiative: a programme involving teenagers, schools, parents and sexual health services in Los Angeles, CA, USA. *Reproductive Health Matters*. 2013; 21(41):124–35. [https://doi.org/10.1016/S0968-8080\(13\)41702-0](https://doi.org/10.1016/S0968-8080(13)41702-0) PMID: 23684195
129. Nsangi A, Semakula D, Glenton C, Lewin S, Oxman AD, Oxman M, et al. Informed health choices intervention to teach primary school children in low-income countries to assess claims about treatment effects: process evaluation. *BMJ Open*. 2019; 9(9):e030787. <https://doi.org/10.1136/bmjopen-2019-030787> PMID: 31511291
130. Nsangi A, Semakula D, Oxman AD, Oxman M, Rosenbaum S, Austvoll-Dahlgren A, et al. Does the use of the Informed Healthcare Choices (IHC) primary school resources improve the ability of grade-5 children in Uganda to assess the trustworthiness of claims about the effects of treatments: protocol for a cluster-randomised trial. *Trials*. 2017; 18(1):223. <https://doi.org/10.1186/s13063-017-1958-8> PMID: 28521838
131. Schonfeld DJ, Bases H, Quackenbush M, Mayne S, Morra M, Cicchetti D. Pilot-testing a cancer education curriculum for grades K-6. *The Journal of School Health*. 2001; 71(2):61–5. <https://doi.org/10.1111/j.1746-1561.2001.tb06492.x> PMID: 11247381
132. Rogow D, Haberland N, Del Valle A, Lee N, Osakue G, Sa Z, et al. Integrating gender and rights into sexuality education: field reports on using It's All One. *Reproductive Health Matters*. 2013; 21(41):154–66. [https://doi.org/10.1016/S0968-8080\(13\)41699-3](https://doi.org/10.1016/S0968-8080(13)41699-3) PMID: 23684198
133. Keselman A, Kaufman DR, Kramer S, Patel VL. Fostering Conceptual Change and Critical Reasoning About HIV and AIDS. *Journal of Research in Science Teaching*. 2007; 44(6):844–63.
134. Kostanjevec S, Erjavšek M, Jedrinović S, Bevčič M, Luštek A, Kozina FL. Development of an Educational Computer Game for Nutrition Education. *Reading: Academic Conferences International Limited*; 2017. p. 343–51.
135. Aghazadeh SA, Aldoory L, Mills T. Integrating Health Literacy Into Core Curriculum: A Teacher-Driven Pilot Initiative for Second Graders. *Journal of School Health*. 2020; 90(8):585–93. <https://doi.org/10.1111/josh.12907> Language: English. Entry Date: PMID: 32510639. Revision Date: 20210802. Publication Type: Article.

136. Alekseeva EG, Krasnopolskaya I, Skokova Y. Introducing sexual education to Russian schools. *Health Education*. 2015; 115(1):7–37. <http://dx.doi.org/10.1108/HE-02-2014-0014>.
137. Drinking-Related Metacognitive Guidance Contributes to Students' Expression of Healthy Drinking Principles as Part of Biology Teaching. *Sustainability*. 2021; 13(4):1939. <http://dx.doi.org/10.3390/su13041939>.
138. Banas JR, Valley JA, Chaudhri A. A biblioguidance approach to understanding and developing adolescents' social-emotional competence in the health education classroom: a formative research study. *Health Education (0965–4283)*. 2021; 121(5):486–503. <https://doi.org/10.1108/HE-01-2021-0008>
139. Fuertes M, Vieira M-J, Ferreira C. Evaluation of an Educational Mediation Programme in Primary Education: M-Educa (Evaluación de un programa de mediación educativa en Educación Primaria: M-Educa). 2022; 45(1):140–65.
140. Modell SM, Bayer IS, Kardias SLR, Morales CJ, Adler I, Greene-Moton E. Health in Our Hands: diabetes and substance use education through a new genomic framework for schools and communities. *Journal of Community Genetics*. 2023; 14(2):211–25. <https://doi.org/10.1007/s12687-022-00631-x> PMID: 36645618
141. Nielsen JN, Saopkota F, Karki J, Singh S, Shakya K, Rahman M, et al. Building adolescent self-efficacy, health and resilience: lessons from Nepal and Bangladesh. *Annals of Nutrition & Metabolism, suppl Supplement 1*. 2023; 79:120. <https://doi.org/10.1159/000530786>.
142. Carlsson M, Simovska V. Exploring learning outcomes of school-based health promotion—a multiple case study. *Health education research*. 2012; 27(3):437–47. <https://doi.org/10.1093/her/cys011> PMID: 22313620
143. Wolf RC, Tawfik LA, Bond KC. Peer promotion programs and social networks in Ghana: methods for monitoring and evaluating AIDS prevention and reproductive health programs among adolescents and young adults. *Journal of health communication*. 2000; 5 Suppl:61–80. <https://doi.org/10.1080/10810730050019564> PMID: 11010358
144. Anderson A, Ronson B. Democracy—The First Principle of Health Promoting Schools. *International Electronic Journal of Health Education*. 2005; 8:24–35.
145. WHO. Guideline: implementing effective actions for improving adolescent nutrition. World Health Organization., 2018.
146. WHO. Global Accelerated Action for the Health of Adolescents (AA-HA!). Guidance to Support Country Implementation. 2018.
147. UNICEF. UNICEF Programme Guidance for the Second Decade: Programming With and for Adolescents. 2018.
148. Wijnhoven Trudy vRJ, Breda João. WHO European Childhood Obesity Surveillance Initiative: implementation of round 1 (2007/2008) and round 2 (2009/2010). WHO. Regional Office for Europe, 2014.
149. Secomb J. A systematic review of peer teaching and learning in clinical education. *Journal of Clinical Nursing*. 2008; 17(6):703–16. <https://doi.org/10.1111/j.1365-2702.2007.01954.x> PMID: 18047577
150. Clarissa Brierley LE, Emily Roisin Reid. Peer-assisted learning in medical education: A systematic review and meta-analysis. *Medical education*. 2022; 56(4):365–73. <https://doi.org/10.1111/medu.14672> PMID: 34595769
151. Dodd S, Widnall E, Russell AE, Curtin EL, Simmonds R, Limmer M, et al. School-based peer education interventions to improve health: a global systematic review of effectiveness. *BMC Public Health*. 2022; 22(1):2247. <https://doi.org/10.1186/s12889-022-14688-3> PMID: 36461024
152. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ: British Medical Journal*. 2014; 348:g1687. <https://doi.org/10.1136/bmj.g1687> PMID: 24609605
153. Phillips AC, Lewis LK, McEvoy MP, Galipeau J, Glasziou P, Moher D, et al. Development and validation of the guideline for reporting evidence-based practice educational interventions and teaching (GREET). *BMC Medical Education*. 2016; 16(1):237. <https://doi.org/10.1186/s12909-016-0759-1> PMID: 27599967