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Review Article

Implications for Geography Education from Research on Climate Change Misinformation – A Systematic Review

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Abstract: Climate change misinformation poses a significant challenge to public understanding of climate science and to education systems as it undermines trust in science and the scientific consensus on anthropogenic climate change. Geography education, positioned at the intersection of human-environment-relations and socio-scientific issues, plays a crucial role in addressing this challenge. However, there is a gap in geography education research regarding how to address climate change misinformation in geography education. Thus, the aim of this systematic literature review is to synthesize empirical research on climate change misinformation in educational contexts to derive implications, with particular relevance for geography education and its research. Following PRISMA guidelines, *n* = 17 peer-reviewed empirical studies were analyzed with respect to research settings, methodological approaches, meta-lenses, assessed learning outcomes (knowledge, strategies, and attitudes) and key findings. The results indicate a predominant focus in secondary education in Global North countries and on qualitative research approaches. Studies tend to prioritize strategy-based and attitudinal outcomes aimed at detecting misinformation, often in digital and social media contexts. In terms of meta-lenses, there is strong emphasis on Nature of Science. Intervention approaches on media literacy as well as inoculation and debunking are highly represented, whereas climate change education and AI-related misinformation remain underrepresented. Based on these findings, the review identifies key gaps in current research and derives implications for future geography education and its research in particular with respect to climate change education.

Keywords: climate change education; climate change misinformation; climate change disinformation; climate change denial; geography education

Highlights:

- Conceptualizes the determinants of climate change misinformation and identifies interventions that address these determinants in the context of climate change education for geography.
- Provides a systematic overview of peer-reviewed empirical studies on climate change misinformation in educational contexts.
- Derives implications for transforming climate change education in geography from the findings of the systematic literature review.

1. Introduction

Climate change education occupies a pivotal position within geography, which serves as a leading subject for Education for Sustainable Development (ESD) (Meadows, 2020) and the development of future-orientated literacies (Chang, 2024). The dissemination of misinformation (see Tab. 1 for information hierarchy) about climate change is particularly detrimental in light of the pressing need to adapt to and lessen anthropogenic climate change as its effects become a more pressing worldwide concern (Puttick, 2025). Learners are increasingly confronted with scientific knowledge but also with competing narratives and deliberate forms of climate change denial (Cook, 2016; Lewandowsky, 2021; Lewandowsky et al., 2024). Responses of the Standard Eurobarometer survey show that within Europe one-third of respondents report being exposed to misinformation either very often (12%) or often (23%) in the past seven days, while 31% indicate occasional exposure and fewer report rare (16%) or no exposure (7%) (European Parliament, 2025).

The widespread use of social media, characterized by unrestricted information flows and the absence of rigorous gatekeeping or scientific peer-review, has accelerated the dissemination of climate change misinformation (Allchin, 2023; Osborne & Pimentel, 2023). Above that, the rise of generative AI (Labadze et al., 2023) and the spread of deepfakes on climate change further pose challenges on learners and adults in evaluating the credibility of information on climate change (Doss et al., 2023).

Thus, a significant responsibility is placed on educational systems and, in particular, on highly interdisciplinary school subjects such as geography in order to build resilience towards climate change misinformation (Chang, 2024; Puttick, 2025). Geography education is uniquely positioned as it integrates social and natural sciences, holds a transformative potential in uncertain times (He et al., 2024) to equip both teachers and students (Lämmer & Ohl, 2026) with powerful knowledge and skills required to recognize and resist climate-related misinformation in uncertain times (Chang, 2023). However, it is important to consider how misinformation is addressed in climate change education contexts, including how educational aims are operationalized in practice and supported by empirical evidence. Review studies have highlighted the growing need to systematize empirical evidence on intervention-oriented responses to misinformation (Kops et al., 2025; Kozyreva et al., 2024; Lämmer & Ohl, 2024; O'Mahony et al., 2023). The present systematic review aims to contribute to the field by synthesizing peer-reviewed studies that are specifically situated in subject-specific education research contexts for addressing climate change misinformation. Specifically, it seeks to identify study contexts, research approaches, map the meta-lenses employed in the literature, assess evidence related to knowledge, strategies, attitudes and summarize key findings. Learning from prior empirical education research is crucial in order to derive evidence-based implications for geography education.

2. Theoretical Background

Despite the well-established scientific consensus on climate change, its anthropogenic drivers, and its ecological, social, and economic impacts, denial of its existence and severity of its impacts persists, often fueled by economic or political interests (Anderson, 2011; Lewandowsky, 2021; Treen et al., 2020). Table 1 presents a conceptual distinction between information, misinformation, and disinformation following the framework proposed by Treen et al. (2020), in which intentionality serves as the key differentiating criterion. Disinformation refers to false or misleading information that is deliberately produced and disseminated, whereas misinformation encompasses false or misleading information regardless of intent. To further clarify this distinction, we draw on the conceptualization by Lewandowsky et al. (2024), which differentiates between liars and believers. Liars are actors who knowingly deny climate change and intentionally spread disinformation, often motivated by political or economic interests (Lewandowsky et al., 2024). In contrast, believers are individuals who accept and reproduce these claims, genuinely believing them to be true, thereby contributing to the spread of misinformation. This distinction underscores how intentionality differentiates disinformation from misinformation. In the following, the term misinformation is used as an umbrella term to encompass all forms of climate change denial, regardless of intent. The conceptualization proposed by the table provides the basis for the consistent use of terminology within this article and highlights that intentionality is serving as the key differentiating criterion. In this article, the term misinformation is thus used.

Geography education includes content from disciplines of social, natural and human sciences providing more holistic notions of teaching climate change education (Cresswell, 2013; He et al., 2024). In geography education, any form

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of climate change denial is particularly critical, as students are expected to understand these complex human-environment interactions and spatial issues across temporal and spatial scales (Rawling, 2022). While geography education aims to treat climate change in a scientifically manner (Tabor & Harrington, 2023), competing worldviews outside the classroom can undermine all learning outcomes or lead students to distinguish between what they learn at school and what they learn "outside" school. The rapid spread of misinformation, particularly via social media, exacerbates this challenge (Guenther et al., 2024). However, without explicit skills to critically assess information on climate change, students are at risk of internalizing misconceptions about climate change and the respective impacts on complex human-environment relationships (Chang & Pascua, 2016; Reinfried & Tempelmann, 2014). For instance, students' diverse conceptual understandings of complex human-environment relations, e.g., regarding the understanding of green-house-effect, may range from scientifically accurate interpretations to non-scientific or erroneous ideas about climate-related processes and climate change (Reinfried et al., 2012). Algorithmic reinforcement in social media can fossilize misconceptions, making them persistent in science-based classroom discussions (Baker & Hawn, 2022). These misconceptions can spread quickly and compromise trust in scientific consensus evidence, ultimately affecting values, decision-making, and democratic engagement (Anderson, 2011; Bromme & Thomm, 2016). Geography education is thus key to therefore prepare students to evaluate conflicting information on climate change critically and responsibly (He et al., 2024; Lambert & León, 2026). Geography teachers are at the center of addressing misinformation, situating it within scientific frameworks, and applying pedagogical strategies to address misunderstandings (Puttick & Talks, 2022), while fostering powerful geography education. Teachers function as multipliers of powerful geographical knowledge towards greater autonomy and sustainability by fostering students' resilience against misinformation on climate change (Lambert & León, 2026). Powerful geographical knowledge is key in order to enable students to understand the interconnections between global and local issues and plays a vital role in empowering them as citizens to recognize their civil rights and engage with global challenges (de Miguel González, 2024; Lambert et al., 2015). To effectively fulfill this role, teachers must be equipped with the skills to address non-scientific claims and misconceptions about climate change. Strengthening teacher agency ensures that classroom practices can reinforce climate change understandings, and empower students to engage responsibly with complex socio-scientific issues and powerful geographies (Lambert & León, 2026; Rushton et al., 2025).

Table 1. Information Hierarchy in the Context of Climate Change (Adapted from *Online misinformation about climate change* (p. 3), by K. M. d'I. Treen, H. T. P. Williams, and S. J. O'Neill, 2020, *WIREs Climate Change, 11*(5), Article e665 (https://doi.org/10.1002/wcc.665).

Information Hierarchy	Definition	Examples for Climate Change Context
Information	All forms of information including claims and data	Scientific reports
Misinformation	Misleading or inaccurate information that is created and spread, regardless of intent	Claims that climate change or a global warming does not exist.
Disinformation	Misleading or inaccurate information that is created and spread with intent	Claims that climate change or a global warming does not exist, when knowingly disseminated to mislead.

Recent review studies have highlighted the growing need to systematize evidence from empirical research aimed at strengthening resilience against different forms of misinformation. Kozyreva et al. (2024) provide a toolbox of individual-level interventions for reducing susceptibility to misinformation, while O'Mahony et al. (2023) identify effective interventions for correcting conspiracy beliefs. Lämmer and Ohl (2024), in turn, offer an overview of the current state of research on primary school children's evaluation of fake news. In addition, Kops et al. (2025) map existing research on young people's responses to false information, including influencing factors, consequences, prevention measures, and intervention efforts. Empirical research on misinformation spans a diversity of disciplinary approaches and lenses highlighting constructs that are important to operationalize in interventions and existing interventions addressing mis-

information in the context of climate change in education contexts. The theoretical section of the present study is structured around two meta-lenses: (1) understanding the determinants of climate change misinformation, and (2) identifying interventions that address these determinants. The first meta-lens refers to theoretical concepts serving as frameworks that seek to understand the determinants of climate change misinformation beliefs, including epistemic, psychological and affective components. The second meta-lens refers to intervention-oriented frameworks that focus on educational strategies designed to address the determinants and build resilience towards climate change misinformation, e.g., inoculation or literacy-based approaches. The following meta-lenses are evident in the literature:

2.1. Understanding the determinants of climate change misinformation

Nature of Science (NOS) and epistemic notions serves as a lens to approach science denial, focusing on how epistemic understandings of scientific knowledge and practices is constituted (Allchin, 2011). The core NOS aspects, including the empirical basis of science, the role of models and simulations, the tentative yet robust nature of scientific knowledge, and the treatment of uncertainty in scientific reasoning define its basis (Lederman et al., 2014). Emphasizing NOS is particularly relevant in the context of climate change, where complex systems, predictions, and model-based evidence are frequently misrepresented in misinformation. In addition, the role and the function of peer review in validating scientific claims is of importance in the context of NOS (Allchin, 2011, 2023). Consequently, NOS-related epistemic skills support capacities to critically evaluate scientific information and to assess the credibility of scientific claims encountered in educational, media, and public discourse (Osborne & Pimentel, 2023).

Psychological and affective components are incorporated as a lens to capture how one responds to climate information, particularly in the presence of misinformation. Pre-existing beliefs and identities can shape the reception of information in ways consistent with identity-protective cognition, leading individuals to preferentially accept information that aligns with their social or ideological group and to discount contradictory evidence (Damico & Baildon, 2022). This cognitive bias reinforces confirmation bias, whereby existing beliefs are strengthened and conflicting information is either ignored or judged less credible (Damico & Baildon, 2022). Additionally, repeated exposure to misinformation can trigger the illusory truth effect, causing false claims to appear more credible simply through familiarity (Pennycook et al., 2020). The consumption of climate-skeptical content online further contributes to echo chambers and algorithmically curated filter bubbles, as search engines and social media platforms tailor content to users' prior beliefs, thereby amplifying misinformation (Hendriks et al., 2015).

2.2. Identifying interventions that address determinants of climate change misinformation

Inoculation and debunking are aimed at countering misinformation. Inoculation theory proposes the design of preventive measures that expose learners to forms of erroneous claims and deceptive strategies to build resilience toward misinformation (Cook, 2016). The FLICC taxonomy (Diethelm & McKee, 2009) classifies five common techniques of science denial: **fake experts** (individuals presented as authorities who lack required disciplinary expertise), **logical fallacies** (arguments that are internally flawed), **impossible expectations** (demanding unrealistic standards of evidence or certainty), **cherry-picking** (selectively presenting data while ignoring inconvenient evidence), and **conspiracy theories** (the belief that a small, covert group is secretly controlling events and shaping narratives with nefarious intent). These categories capture recurring rhetorical techniques used in climate change denial and other forms of misinformation, and they provide a framework for designing inoculation interventions that help individuals recognize and resist such misleading arguments (Cook, 2016; Hopkins et al., 2023). Following direct exposure to misinformation, debunking strategies, including topic rebuttals and technique rebuttals, can be applied (Schmid & Betsch, 2019). In a topic rebuttal, the misinformation itself is not reiterated; instead, the focus is on presenting stronger, evidence-based facts that for example accurately reflect the scientific consensus (Schmid et al., 2018). By contrast, a technique rebuttal critically examines the form and persuasive techniques of the misinformation, emphasizing critical thinking skills to detect and evaluate the methods used to make false claims appear convincing rather than focusing solely on their content (Schlamelcher et al., 2025; Schmid, 2023).

Climate change education (CCE) refers to the process of teaching and learning about the science, causes, impacts, and solutions related to climate change (Monroe et al., 2019). It is aimed at a scientific understanding of social and natural phenomena related to it as part of human-environment relations (Tabor & Harrington, 2023), and for individuals and the collective to take concrete action to mitigate and adapt to climate change (Chang, 2023, 2024; Monroe et al.,

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2019). To this end, it focuses both on imparting knowledge (the causes of climate change, its effects and its mitigation and adaptation management) and on developing skills, competences, values and motivating attitudes, including ethical responsibility, decision-making skills and future-oriented thinking (Chang, 2023). By fostering agency and empowerment, CCE aims to counteract feelings of helplessness or disengagement and instead support learners in developing a sense of efficacy and hope in the face of a complex and often overwhelming global challenge (Li & Monroe, 2019; Ranney & Velautham, 2021). In this sense, CCE explicitly addresses cognitive, affective, and normative dimensions of learning, acknowledging that climate change is apart from being a scientific issue also one that raises questions of collective responsibility and justice (Puttick, 2025).

Media literacy constitutes a further lens, capturing capacities to access, evaluate, analyze, and responsibly produce information within contemporary media environments (Potter, 2010). Conventional media literacy instruction already underscores the importance of attending to the credibility of sources, emphasizing how distinguishing trustworthy information from biased, misleading, or fabricated sources (Osborne & Pimentel, 2023). In educational contexts, this often includes cautioning about pseudoscientific claims encountered in advertising, entertainment, and promotional media, practices that are directly transferable to the detection of climate change misinformation, e.g., through lateral reading (Allchin, 2023; Brodsky et al., 2021). This may also include evaluating who is behind the information, their expertise,and credibility, e.g., civic online reasoning (McGrew, 2020). In the context of complex issues such as climate change, media literacy extends beyond source evaluation to include the critical analysis of framing, and digital representations that shape public understanding of scientific evidence.

AI literacy in evaluating AI-generated misinformation and deepfakes on climate change, reflects the growing role of advanced generative artificial intelligence in producing mis- and disinformation on climate change. Addressing synthetic media and AI-driven persuasive content that may distort scientific information or simulate authenticity. This lens is particularly relevant for climate change education in online environments, where generative AI tools can amplify false or misleading climate narratives, generate deepfakes and complicate abilities to critically evaluate sources and evidence (Chesney & Citron, 2019; Vaccari & Chadwick, 2020). Developing AI literacy especially in evaluating AI-generated content, affordances, and risks of AI-generated content extends broader media literacy efforts aimed at detecting mis- and disinformation (OECD, 2025). On the other hand, AI literacy entails new possibilities for tailored climate communication by adapting information to individual characteristics and needs. Initial evidence suggests that such personalisation can influence climate-related attitudes and behavioral intentions (Remshard et al., 2026). In the context of climate misconceptions, AI may be especially relevant as it can recommend feasible, high-impact mitigation actions that are aligned with learners' circumstances, potentially improving understanding of climate change (Bueno-Picazo & Tirado-Olivares, 2026) and effective climate behavior (Pearson et al., 2026; Remshard et al., 2026).

3. Research Questions

Three research questions guide the systematic analysis of empirical research on climate change misinformation in educational contexts.

1. **RQ1:** How are empirical studies addressing climate change misinformation designed with regard to research settings and methodological approaches?
2. **RQ2:** Which meta-lenses are operationalized in empirical studies on climate change misinformation?
3. **RQ3:** Which assessed learning outcomes (knowledge, strategies, attitudes) and key findings are represented in empirical studies on climate change misinformation?

Together, these questions enable a structured synthesis of methodological and theoretical patterns and findings in the literature, providing a basis for identifying dominant approaches, gaps, and implications for geography education and its research toward powerful geography teaching.

4. Materials and Methods

4.1 Search Strategy

To address the research questions, the review provides a comprehensive and transparent synthesis of empirical research. Through the use of a structured search strategy in Web of Science and Scopus, as well as the application of PRISMA-aligned screening procedures, this review provides a systematic overview of the current evidence regarding climate change misinformation and outlines the implications for geography education. The present systematic overview

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highlights gaps and blind spots in existing research, and clarifies areas where further investigation is needed particularly with regard to the role of geography education in countering climate-related misinformation.

A systematic literature search was conducted on November 11, 2025, using the Web of Science Core Collection. Web of Science was selected because it provides a large number of peer-reviewed journal articles and includes a high number of high-impact journals, thereby ensuring the quality of the sample. The search string was adapted to the Web of Science topic search (TS=) and included three conceptual blocks: climate change, misinformation/disinformation, and educational contexts:

TS = (("climate change" OR "global warming") AND ("misinformation" OR "disinformation" OR "false belief*" OR "myth*" OR "fake" OR "deepfakes" OR "AI") AND ("educat*" OR "teach*" OR "curriculum*" OR "school*"))

The search yielded 308 records. Following the initial review process, a second search was conducted in Scopus using an adapted appropriate for the database, while maintaining the same conceptual structure and time frame. The Scopus search yielded 298 records. Studies published between January 1, 2018, and November 11, 2025, were included in the review. Eligibility criteria were defined prior to screening and aligned with PRISMA guidelines.

Studies were included if they were empirical in nature, employing qualitative, quantitative, or mixed-methods research designs. To be eligible, publications had to be written in English and report primary data collected from students, teachers, or other educational stakeholders. Furthermore, studies needed to focus explicitly on climate change misinformation, disinformation, denial or related constructs, and they had to be situated within an educational or teaching context. However, studies in nursing, engineering, marketing, or agricultural education were excluded. Also, articles that focused predominantly on political discourse, ideological debates, or media framing unrelated to education were also excluded. In addition, theoretical papers without empirical data were not considered. Literature reviews were removed. Papers that did not involve an educational environment or sample were likewise excluded from the review.

4.2 Screening Process

All records retrieved through the initial search were screened using a systematic two-phase process. In the first phase, titles, abstracts and keywords were reviewed to exclude publications that did not meet inclusion criteria or to the research focus. A second independent rater screened titles, abstracts, and keywords. Interrater reliability, assessed using Cohen's κ, indicated near-perfect agreement (κ = 0.96; Brennan & Prediger, 1981). Any discrepancies were resolved through discussion. The second phase involved full-text screening, during which predefined inclusion and exclusion criteria were rigorously applied. Figure 1 shows the process and the structure recommended by PRISMA to ensure transparency and reproducibility in study selection (Page et al., 2021; Xiao & Watson, 2019).

4.3. Quality Appraisal (MMAT)

In addition to following the PRISMA guidelines, a methodological quality appraisal was conducted using the Mixed Methods Appraisal Tool (MMAT). Studies that met fewer than three out of the five criteria were considered to be of lower methodological quality and were therefore excluded from the review, while studies meeting three to five criteria were classified as of medium to high quality and treated equally within the present study. Following the quality appraisal (n = 2) were excluded from the study (Hong et al., 2018).

4.4. Data Extraction and Analysis

N = 17 Studies were included into the present literature review. For each included study, relevant information was systematically extracted. To ensure a systematic approach to data extraction, theory-drive, deductive categories based on the two meta-lenses (see Tab. 2): (1) understanding the determinants of climate change misinformation, and (2) identifying interventions that address these determinants, which were applied to the publications. Studies were assigned to the meta-lenses when they explicitly referred to corresponding theoretical constructs in their theoretical background sections, which served as a primary coding criterion. Where studies addressed more than one lens, multiple assignments were permitted. In addition, data-driven, inductive categories were developed in alignment with the studies. These inductive categories (see Tab. 3) were additionally used to systematize the literature according to the study

settings, methodologies, assessed outcomes related to knowledge, strategies, or attitudes and key findings. The extracted data were then synthesized, with particular attention to the deductive (see Tab. 2) as well as inductive categories (see Tab. 3) that emerged regarding how climate change misinformation is addressed in educational settings.

Figure 1. PRISMA Flow Diagram Adapted Based on Page et al. (2021)

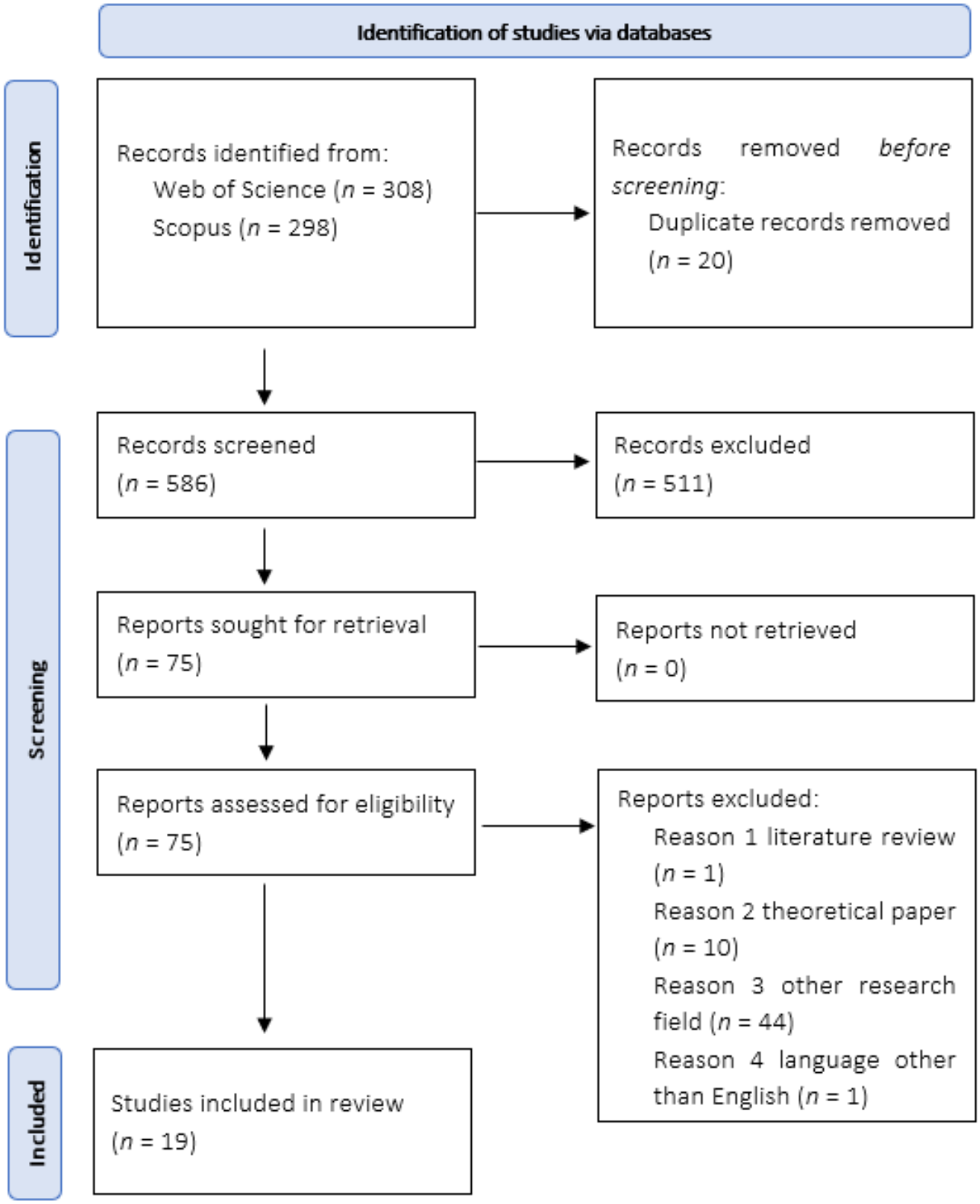

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Table 2. Deductive Categories Developed for Synthesizing the Included Literature

Main Category	Subcategory	Definition
Determinants of climate change misinformation	Nature of Science (NOS) / Epistemic Notions	Empirical, tentative, socially embedded, and validated nature of scientific knowledge and practices.
	Psychological / Affective Components	Cognitive and emotional processes that influence how individuals interpret and respond to climate change (mis-)information.
Intervention-approaches that address determinants of climate change misinformation	Inoculation & Debunking	Preventive and corrective approaches aimed at strengthening resistance to misinformation.
	Climate change education (CCE)	Climate change education refers to the process of teaching and learning about the science, causes, impacts, and solutions related to climate change.
	Media Literacy	Skills to access, analyze, evaluate, and create media content in context (e.g., lateral reading).
	AI Literacy	Skills to understand and critically evaluate AI-generated information and deepfakes, as well as to engage with AI in order to dispel misinformation.

Table 3. Inductive Categories Developed for Synthesizing the Included Literature

Main Category	Subcategory	Definition
Study Setting	Location	The geographical setting in which the study was conducted.
	Domain	Taught disciplinary domain or subject area with shared body of knowledge, skills and practices.
	Primary Education	Educational level corresponding to ISCED[1] 1.
	Secondary Education	Educational level corresponding to lower and upper secondary education (ISCED 2-3).
	Tertiary Education	Educational level corresponding to higher education including Bachelor and Master (ISCED 6-7).
	Pre-Service Teachers (PST)	Student teachers who have not yet entered professional teaching practice.
	In-Service Teachers (IST)	Practicing teachers who have entered professional teaching practice.
	University Educators (UE)	Academic staff who are involved in higher education teaching.
	Sample size	Total count of participants or cases selected from a population
Methodology	Qualitative Approach	A research design that primarily employs qualitative methods (e.g., interviews, focus groups, observations, document analysis) to collect and analyze non-numerical data.
	Quantitative Approach	A research design that primarily employs quantitative methods (e.g., surveys, experiments, statistical analyses) to collect and analyze numerical data.
	Mixed-Methods Approach	A research design that integrates both qualitative and quantitative methods within a study.

[1]International Standard Classification of Education

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Outcomes Assessed	Knowledge	Outcomes related to participants' factual knowledge of climate change, including scientific concepts, causes and effects of climate change
	Strategy	Outcomes related to participants' strategy knowledge or skills for identifying climate change misinformation (e.g., critical evaluation strategies, source evaluation, deceptive strategy analysis).
	Attitudes	Outcomes related to participants' attitudes, beliefs, or dispositions regarding education on climate change and misinformation (e.g., trust in scientific consensus, self-efficacy in detecting misinformation).
	Key finding	Narrative summary of key findings

4. Results

RQ1: How are empirical studies addressing climate change misinformation designed with regard to research settings and methodological approaches?

Table 4 summarizes a total of *n* = 17 empirical studies examining climate change misinformation in educational contexts. The findings are systematized along four main dimensions: location, research settings and methodological approaches. Selected studies are referenced to illustrate key foci and patterns; however, a detailed discussion of each individual study is beyond the scope of this section.

Across the reviewed literature, studies were conducted in a diverse range of spatial contexts, with a strong concentration in the United States (*n* = 8), followed by European countries such as Germany (*n* = 2) or Austria (*n* = 2), and one study with cross-national settings. The results show a predominantly so-called Global North research focus, with comparatively fewer studies situated in the so-called Global South. Most studies label the disciplinary domain as science (*n* = 6) or leave it unspecified (*n* = 5), with only a few focusing on specific subjects such as physics, chemistry, STEM, or English language arts.

In terms of educational study settings, the majority of studies focused on secondary education (*n* = 8). Examples include interventions with secondary school students in Israel (Abed & Barzilai, 2023), Australia (Arnot et al., 2024), Germany (Kresin et al., 2024; Kresin et al., 2025), Sweden (Nygren & Guath, 2022) or UK (Siani et al., 2024). A smaller number addressed tertiary education (*n* = 4) with studies from the USA (Cook et al., 2023; Levy et al., 2025) and Austria (Bernsteiner et al., 2023). Teacher-related contexts (*n* = 6), including pre-service teachers and in-service teachers. No studies explicitly targeted primary education. Sample sizes vary widely: some qualitative studies work with very small groups (e.g., Perkins et al., 2018), whereas the largest survey-type studies include more than 2,000 participants (Doss et al., 2023; Nygren & Guath, 2022).

Regarding methodological approaches, qualitative methods are most prevalent across the studies (*n* = 11), employing semi-structured interviews (e.g., Arnot et al., 2024; Keener, 2020), focus group interviews (e.g., Kresin et al., 2024; Kresin et al., 2025), or qualitative task analyses to explore how participants respond to climate change misinformation detection tasks (e.g., Abed & Barzilai, 2023; Cook et al., 2023; Poor et al., 2025; Saribas & Çetinkaya, 2025). Quantitative designs (*n* = 6) are also represented, including surveys (e.g., Doss et al., 2023), experimental designs (e.g., Levy et al., 2025; Nygren & Guath, 2022), and quasi-experimental designs. A smaller subset of studies employed mixed-methods approaches (*n* = 3), combining quantitative outcome measures with qualitative insights (e.g., Bernsteiner et al., 2023). This distribution of methods represents an emphasis on qualitative insights rather than standardized effect measurement.

RQ 2: Which meta-lenses are operationalized in empirical studies on climate change misinformation?

Based on Table 5, the representation of meta-lenses across the *n* = 17 reviewed empirical studies reveal a high diversity (1) determinants of climate change misinformation belief, and (2) interventions that address these determinants, yet a discernible distribution indicating clear emphases in meta-lenses that are represented.

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Table 4. Results on the Assessed Studies with Regards to Research Settings and Methodology (Note: PST = Pre-service teachers, IST = In-service teachers, UE = University educators.)

Citations	Setting							Methodology			
	Location	Domain	Secondary	Tertiary	PST	IST	UE	Sample Size	Quantitative	Qualitative	Mixed-Methods
Abed and Barzilai (2023)	Israel	unspecified	x					*n* = 40	x	x	
Arnot et al. (2024)	Australia	unspecified	x					*n* = 28		x	
Bernsteiner et al. (2023)	Austria	Physics			x			*n* = 24			x
Cook et al. (2023)	USA	Science		x				*n* = 3 cases		x	
Doss et al. (2023)	USA	unspecified	x	x		x		*n* = 3035	x		
Henderson et al. (2025)	USA	Science				x		*n* = 226			x
Keener (2020)	USA	STEM		x				*n* = 10		x	
Kresin et al. (2024)	Germany	Science	x					*n* = 21		x	
Kresin et al. (2025)	Germany	Science	x					n = 26		x	
Lathrop (2025)	USA	English Language Arts	x			x		*n* = 13 students *n* = 1 teacher		x	
Levy et al. (2025)	USA	unspecified		x				*n* = 279	x		
Nygren and Guath (2022)	Sweden	Multiple	x					*n* = 2216	x	x	
Perkins et al. (2018)	Brazil, China, Germany, USA	unspecified					x	*n* = 6		x	
Poor et al. (2025)	USA	Multiple					x	*n* = 14			x
Saribas and Çetinkaya (2025)	Turkey	Science			x			*n* = 40		x	
Schubatzky and Haagen-Schützenhöfer (2022)	Austria	Physics			x			*n* = 20	x		
Siani et al. (2024)	UK	Science	x					*n* = 776	x	x	
Total [*n*]			**8**	**4**	**3**	**3**	**3**		**6**	**11**	**3**

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Table 5. Results on the Key Meta-Lenses - Determinants and Intervention-Approaches that Address Determinants in the Context of Climate Change Misinformation

Citations	Key Meta-Lenses					
	Determinants of Climate Change Misinformation		Intervention-Approaches that Address Determinants of Climate Change Misinformation			
	Psychological / Affective Components	Nature of Science Epis-temic Notions	Climate Change Education	Inoculation & Debunking	Media Literacy	AI Literacies (e.g., detect deepfakes)
Abed and Barzilai (2023)	x	x			x	
Arnot et al. (2024)	x				x	
Bernsteiner et al. (2023)				x		
Cook et al. (2023)				x		
Doss et al. (2023)					x	x
Henderson et al. (2025)	x		x			
Keener (2020)	x				x	
Kresin et al. (2024)		x		x	x	
Kresin et al. (2025)	x	x		x	x	
Lathrop (2025)		x			x	
Levy et al. (2025)	x	x	x			
Nygren and Guath (2022)					x	
Perkins et al. (2018)			x			
Poor et al. (2025)		x				
Saribas and Çetinkaya (2025)		x			x	
Schubatzky and Haagen-Schützenhöfer (2022)				x		
Siani et al. (2024)	x	x				
Total [*n*]	**7**	**8**	**3**	**5**	**9**	**1**

4.1. Determinants of climate change misinformation belief

Nature of Science (NOS) and epistemic notions constitute a highly represented lens, appearing in *n* = 9 studies. These results show an emphasis on how scientific knowledge is produced, the norms governing scientific practice (e.g., Lathrop, 2025), and key aspects such as uncertainty, consensus, and the evaluation of expertise to determine whom to trust (e.g., Saribas & Çetinkaya, 2025). Such epistemic insights were referred to as crucial mechanisms for resisting climate change misinformation (e.g., Abed & Barzilai, 2023; Poor et al., 2025). **Psychological and affective** components including learners' attitudes, emotions, and motivational factors are addressed in *n* = 8 studies. These contributions investigate variables such as climate risk perception (e.g., Arnot et al., 2024), self-efficacy in detecting misinformation (Bernsteiner et al., 2023), emotional engagement, and interest in climate-related issues, often in combination with media literacy or civic education frameworks (e.g., Henderson et al., 2025; Keener, 2020; Levy et al., 2025). Several studies highlight how emotions like worry or fear about climate change can both motivate learning and, make learners more susceptible to misinformation if not coupled with strategies for critical evaluation. Self-efficacy emerges as another key factor, with higher levels associated with greater confidence in discerning credible information and taking informed

action (Keener, 2020). This lens underscores a growing recognition that learners' cognitive engagement with misinformation is deeply intertwined with their affective states.

4.2. Interventions that address these determinants

Overall, **media literacy** constitutes the most frequently represented intervention-approach. *N* = 9 studies explicitly operationalize media literacy constructs, focusing on learners' abilities to evaluate sources, detect misleading framing of climate change, and critically engage with content such as social media posts, online news, or platform-specific formats (e.g., Abed & Barzilai, 2023; Kresin et al., 2024; Kresin et al., 2025). These studies frame climate change misinformation as a problem of information quality and source credibility within online environments, underscoring the central role of media literacy in empirical research on climate change misinformation in education. Concrete approaches include civic online reasoning (Keener, 2020; Nygren & Guath, 2022) and lateral reading practices, particularly cross-checking claims across multiple independent sources (Lathrop, 2025).

Inoculation and debunking strategies form a less prominent intervention cluster in the literature, represented in *n* = 5 studies. These theoretical lenses focus on both preventive and reactive approaches to countering climate change misinformation. Preventive strategies, often referred to as prebunking or inoculation interventions, aim to equip learners with foreknowledge of common deceptive tactics, such as those described in the FLICC taxonomy (e.g., Cook et al., 2023), whereas reactive strategies directly applied. Two studies explicitly combine inoculation and debunking approaches, thereby integrating pre- and reactive strategies to detect and counter misinformation especially based content or technique rebuttal (Bernsteiner et al., 2023; Schubatzky & Haagen-Schützenhöfer, 2022). This combined approach represents the potential for synergizing preventive and corrective mechanisms.

Climate change education is comparatively underrepresented among intervention approaches addressing climate change misinformation (*n* = 3). Existing studies examine climate change education from teachers' perspectives (Henderson et al., 2025) or explore how climate change education can be strengthened to counteract misinformation (Levy et al., 2025). Climate change education is further framed as a complex instructional domain, with suggested approaches including inquiry-based teaching, case studies, simulations and games, and problem-centered designs aimed at connecting climate concepts to real-world action (Perkins et al., 2018).

AI literacy, particularly with regard to detecting AI-generated misinformation or deepfakes, is less prominently represented. Only one study explicitly addresses AI-related content detection (Doss et al., 2023).

> ***RQ3:*** *Which* assessed outcomes (knowledge, strategies, and attitudes) and key findings are represented in empirical studies on climate change misinformation?

Table 6 illustrates which study outcomes related to knowledge, strategies, and attitudes, are assessed in empirical studies on climate change misinformation and what key findings are reported summarized in one sentence is represented in Table 7. Across the reviewed studies, outcomes were unevenly distributed, with a clear emphasis on attitudinal outcomes and strategy-related outcomes, followed by content-related knowledge gains, assessed less frequently.

4.3. Assessed Knowledge Outcomes

Knowledge-related outcomes were addressed (*n* = 7), particularly in studies employing quantitative or mixed-methods designs. Knowledge-related outcomes were rarely the primary focus of climate change misinformation-oriented studies. Where measured, findings suggest that learners are capable of acquiring substantive climate- and science-related knowledge through targeted instruction. For example, students in climate-related courses demonstrated content mastery on core scientific concepts following brief climate change education video interventions significantly increased knowledge on climate science facts, and strengthened perceptions that climate change is real, serious, and human-caused (e.g., Abed & Barzilai, 2023; Levy et al., 2025). Self-reported knowledge gains were also documented in several intervention studies, with participants reporting statistically significant increases in perceived climate change knowledge following instructional units (Schubatzky & Haagen-Schützhöfer, 2022). In some cases, these gains were accompanied by medium effect sizes. However, knowledge gains were often framed as supportive outcomes rather than as central explanatory

Table 6. Results on the Assessed Outcomes

Citations	Assessed Outcomes on		
	Knowledge	Strategy	Attitude
Abed and Barzilai (2023)	x	x	
Arnot et al. (2024)		x	x
Bernsteiner et al. (2023)	x	x	x
Cook et al. (2023)		x	x
Doss et al. (2023)		x	x
Henderson et al. (2025)			x
Keener (2020)		x	x
Kresin et al. (2024)		x	
Kresin et al. (2025)		x	
Lathrop (2025)		x	x
Levy et al. (2025)	x		x
Nygren and Guath (2022)		x	x
Perkins et al. (2018)	x	x	
Poor et al. (2025)	x		x
Saribas and Çetinkaya (2025)			
Schubatzky and Haagen-Schützenhöfer (2022)	x	x	x
Siani et al. (2024)	x	x	x
Total [*n*]	**7**	**13**	**12**

4.4. Assessed Strategy Outcomes

Strategy-oriented learning outcomes are most frequently examined across the reviewed studies (*n* = 13), particularly in online contexts such as YouTube and social media environments (Abed & Barzilai, 2023; Kresin et al., 2024; Kresin et al., 2025; Lathrop, 2025; Siani et al., 2024). Across these studies, credibility evaluation emerged as a holistic and multi-dimensional process. For example, learners shifted from relying on superficial credibility cues (e.g., the use of a ".org" domain) toward applying lateral reading and more rigorous evidence evaluation strategies following targeted media literacy instruction (Lathrop, 2025). Evaluations of scientific YouTube videos were found to closely resemble how learners assess scientific webpages, indicating limited adaptation of evaluative strategies to audiovisual formats (Abed & Barzilai, 2023). The use of multiple criteria was associated with a higher likelihood of identifying credible information. For instance, studies further reported that inoculation and debunking interventions led to improvements in self-efficacy when it comes to misinformation detection strategies, particularly when combined (e.g., Bernsteiner et al., 2023; Schubatzky & Haagen-Schützenhofer, 2022). However, these gains were often accompanied by persistent difficulties in articulating the underlying mechanisms of misinformation. In particular, learners struggled to explicitly explain abstract misinformation techniques, such as those captured in the FLICC taxonomy (Bernsteiner et al., 2023). Game-based inoculation approaches was associated with high levels of learner engagement in detecting misinformation on climate change (Cook et al., 2023). Above that, research on civic online reasoning was effective (Nygren & Guath, 2022), however it was consistently highlighted that reasoning processes are highly individualized. One deepfake-focused study

revealed particularly acute strategic challenges. Between 27% and over 50% of participants across different populations misidentified video authenticity, with adults—including teachers and school leaders—often demonstrating greater vulnerability than students. While attention to technical cues (e.g., video quality or facial features) supported detection to some extent, strategies incorporating social and contextual analysis, such as assessing speaker familiarity, plausibility, and content credibility, were more effective in identifying both deepfake and authentic videos (Doss et al., 2023).

Table 7. Narrative Summary of Key Findings

Citations	Key Findings
Abed and Barzilai (2023)	Students evaluated scientific YouTube videos primarily by focusing on communicative and explanatory features rather than source credibility, used evaluation strategies similar to those applied to scientific webpages, and relied on epistemic criteria that predicted perceived video quality but insufficiently accounted for the credibility of the content and its sources.
Arnot et al. (2024)	Australian students view the climate crisis as an urgent and interconnected threat to human, animal, and environmental health, explicitly express empathy for vulnerable populations, those in lower-middle-income countries disproportionately affected and, finding school-based education insufficient, seek information from alternative sources while emphasizing the need for credible climate information to counter misinformation.
Bernsteiner et al. (2023)	The intervention increased future teachers' self-efficacy and ability to detect misinformation and was perceived as valuable for their future teaching, but despite these gains, participants continued to struggle with high-quality debunking in explicitly identifying and explaining underlying FLICC misinformation techniques.
Cook et al. (2023)	Across three case studies, the humor-based inoculation game effectively engaged learners and supported the transfer of fallacy recognition skills to creative and applied tasks, achieved high participation and performance levels, and, while scalable and engaging, also elicited predictable political pushback, underscoring inherent resistance to misinformation inoculation efforts.
Doss et al. (2023)	The study shows that current deepfakes already cause substantial confusion among education stakeholders, often more so among adults than students, while effective detection depends less on technical cues than on social-contextual evaluation, and vulnerability is shaped by age and trust in sources, underscoring the need for explicit, targeted deepfake literacy rather than reliance on exposure or visual scrutiny alone.
Henderson et al. (2025)	Individual teachers' political orientation strongly influenced how they taught climate change undermining scientific content among more conservative teachers, while school district political leaning and geographic location had no significant effect on instruction.
Keener (2020)	Media informational reasoning varies individually, is guided largely by motivated interests and political identity, relies on strategies such as bias detection and consensus checking, and is minimally influenced by cultural, ethnic, or gender identities.
Kresin et al. (2024)	Students evaluate credibility holistically using multiple criteria across content, source, and composition dimensions, which together increase the likelihood of identifying credible information, though they are often less aware of how composition-based criteria influence their judgments.
Kresin et al. (2025)	Students are generally aware of social media communication mechanisms, primarily through personal experience, with conceptions ranging from basic descriptions to elaborate understandings that include operational details, consequences, and potential user manipulation.
Lathrop (2025)	The unit significantly improved students' climate change attitudes and evidentiary reasoning, fostering a complex, socially and cognitively informed approach to knowledge through a "critical media epistemology" that integrates Critical Media Literacy, epistemic cognition, and out-of-school digital literacy practices, though transferring these skills beyond the classroom remains challenging.

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Levy et al. (2025)	Brief, solution-oriented climate change education videos reduced denial, increased acceptance of scientific facts and hope for mitigation, boosted support for climate-friendly policies, and decreased negative emotions, with effects persisting in post-tests.
Nygren and Guath (2022)	Valuing credible news, studying in a Natural Science program, and speaking Swedish at home all positively influenced students' performance on civic online reasoning tasks, including sourcing, evidence evaluation, and corroboration, while vocational students performed comparatively lower.
Perkins et al. (2018)	Climate change pedagogy across the studied countries is shaped by contextual factors including the Paris Agreement, political and economic barriers, sustainability initiatives, and university-industry linkages with experts converging on five sustainability education goals (teaching scientific complexity, providing comprehensive knowledge, fostering critical inquiry, using transformative approaches, and enabling student participation).
Poor et al. (2025)	Scientists prioritize communicating the social benefits of science over detailed methodological explanations, while cautioning that emphasizing subjectivity in scientific work may undermine public trust.
Saribas and Çetinkaya (2025)	The study found that pre-service teachers displayed a split in reasoning, with about half evaluating information and evidence at a high level and half at a low level across both pseudoscientific and scientific texts, with their conceptual understanding of science influencing credibility evaluations.
Schubatzky and Haagen-Schützenhöfer (2022)	The intervention significantly increased participants' perceived climate change knowledge, enhanced both the quantity and quality of their debunking skills, and improved their myth-debunking self-efficacy, which, measured after the debunking task, was significantly higher and positively correlated with debunking scores.
Siani et al. (2024)	The key finding is that secondary school students become less susceptible to scientific misinformation as they progress through school, while trusting teachers as the most reliable source of scientific news.

4.5. Assessed Attitude Outcomes

Attitudinal outcomes to climate change misinformation detection are examined highly in *n* = 12 included studies. These outcomes primarily address attitudes toward climate change misinformation, including beliefs about its credibility and self-rated self-efficacy to detect and counter misinformation (e.g., Bernsteiner et al., 2023; Henderson et al., 2025; Lathrop, 2025; Nygren & Guath, 2022; Schubatzky & Haagen-Schützenhöfer, 2022). Teacher-focused studies indicate that professional attitudes and identity-related dispositions play a substantial role in shaping how climate change including misinformation is addressed in educational contexts. Individual teachers' political orientations influenced whether and how misinformation was explicitly discussed, with more conservative orientations associated with reduced emphasis on scientific consensus. In contrast, institutional characteristics and geographic location showed little association with instructional practices, underscoring the primacy of individual beliefs. Across studies, motivated interests and political identity consistently were represented as salient attitudinal factors influencing climate change misinformation handling (Cook et al., 2023; Henderson et al., 2025; Keener, 2020).

Among pre-service teachers, instructional approaches centered on inoculation and debunking strategies were perceived as highly relevant for future professional practice, particularly as it was perceived to be aligned with education for sustainable development (Bernsteiner et al., 2023; Schubatzky & Haagen-Schützhöfer, 2022). At the secondary education level, empathy-oriented instructional approaches supported students' engagement with climate-related misinformation by fostering concern for the societal and planetary implications of misleading claims, alongside an emerging understanding of interconnected environmental, social, and health risks (Arnot et al., 2024). Several intervention studies documented positive attitudinal shifts related to climate change misinformation processing. Delayed posttests further indicated reductions in negative affective responses, such as worry and helplessness, suggesting sustained affective benefits alongside cognitive changes (Levy et al., 2025). Attitudes toward information credibility were also systemati-

cally linked to performance: participants who placed greater value on credible news sources demonstrated higher accuracy in source credibility evaluation tasks involving climate change misinformation (Nygren & Guath, 2022). At the same time, a study focusing on higher education educators cautions that emphasizing subjective or identity-laden aspects of scientific work may undermine trust and provide leverage for misinformation actors, highlighting tensions in how attitudinal framing can influence trust in Nature of Science (Poor et al., 2025).

5. Discussion

The purpose of this systematic literature review was to gain a better understanding of empirical research on climate change misinformation in educational contexts, with particular attention to research settings, methodological approaches, underlying meta-lenses and assessed knowledge, strategy, attitude outcomes as well as key findings. Taken together, the findings indicate that research on climate change misinformation in education is an emerging and expanding field, yet one that remains unevenly developed across research settings, with heterogenous meta-lenses and a clear trend on assessed outcomes regarding strategy-oriented approaches.

There are four key findings of the present study:

- First, empirical research on climate change misinformation is strongly concentrated in secondary and tertiary education contexts and is predominantly situated in countries of the Global North. The results strongly imply that current knowledge about how learners engage with, detect, and respond to climate change misinformation is largely shaped by educational systems, political cultures, and media environments specific to these regions.
- Second, the literature is characterized by a methodological emphasis on qualitative and exploratory designs, with comparatively limited use of longitudinal, experimental, or mixed-methods approaches. It is interesting to note that the present set of findings is that climate change misinformation is multidimensional and complex and highly context-dependent phenomenon that is addressed through in-depth exploration.
- Third, the analysis of meta-lenses reveals a clear divide between frameworks aimed at understanding determinants of misinformation beliefs and those designed to address these determinants through educational interventions. Our findings highlight that Nature of Science, including epistemic notions (e.g., Allchin, 2011, 2023), is most frequently represented and used to explain why learners may be susceptible to climate change misinformation. Studies adopting a NOS perspective tend to frame misinformation not as a deficit in factual knowledge, but as a challenge to learners' epistemic reasoning, highlighting the importance of cultivating an epistemic understanding of how science works and who to trust in identifying climate change expertise. At the same time, media literacy (Brodsky et al., 2021; Potter, 2010), as well as inoculation and debunking approaches (Cook, 2016), dominate as intervention-oriented frameworks.
- Fourth, across studies, strategy-oriented and attitudinal outcomes dominate, whereas content-related outcomes on climate science knowledge is assessed less frequently and rarely serves as the primary focus of interventions. This finding merit comment as knowledge outcomes are rarely positioned as the primary focus of studies. The results strongly imply that researchers conceptualize climate change misinformation less as a deficit of scientific knowledge and more as a challenge of credibility evaluation, which is in line with Allchin (2023) and Osborne and Pimentel (2023). This idea is further supported by the consistent finding that improvements in misinformation detection strategies are at the center or the studies, which also include attitudinal outcomes in self-efficacy, trust in information sources, and political or identity-related attitudes (Anderson, 2011; Bromme & Thomm, 2016). Although the overall number of studies in this review is relatively small, the findings suggest that inoculation and debunking strategies are increasingly recognized as effective and complementary components of educational interventions addressing climate change misinformation.

Despite these trends, the review also reveals notable blind spots. It is interesting that primary education contexts remain markedly underrepresented, a finding also supported by Lämmer and Ohl (2024). In addition, marginal attention to AI-related misinformation and AI-approaches to counteract misinformation represent a critical omission in light of rapidly evolving use and spread of AI-content. As AI-generated texts, images, and videos increasingly shape climate-related communication, research must expand its focus to include AI literacy as a component of climate change education (Chesney & Citron, 2019; Vaccari & Chadwick, 2020).

Although the present results clearly support the conclusion that climate change misinformation education is an expanding research field, it is appropriate to recognize several potential limitations. A first limitation concerns the search strategy, which was restricted to peer-reviewed publications written in English and indexed in Web of Science and Scopus. It is possible that relevant studies published in other languages from Global South contexts were not captured. This

may have introduced a Global North bias, limiting the geographical representativeness and generalizability of the findings. A second potential limitation is that the review excluded gray literature such as conference proceedings, project reports, and policy evaluations. Although this decision ensured a focus on peer-reviewed research with established quality standards, it may have led to the omission of practice-oriented work, especially in a rapidly evolving field such as climate change misinformation education. A third limitation concerns the scope of included studies. The present review focused exclusively on empirical research that evaluated interventions or measured learning outcomes. Consequently, a substantial body of conceptual or descriptive literature was excluded. In addition, several of the included studies rely on relatively small or context-specific samples, which may constrain the generalizability of individual findings across different educational settings and socio-cultural contexts. Another limitation of this study concerns the potential conceptual overlap between certain deductively derived categories based on the meta-lenses' framework and inductively generated outcome-related categories as these highly interrelate. Although beyond the scope of the present review, such work offers valuable insights into conceptualizations of determinants of climate change misinformation and inform intervention-approaches related to climate change education. Finally, another limitation of this study is the relatively small sample of 17 studies, which reflects the still-emerging nature of research in this field.

6. Implications for Geography Education and Geography Education Research

The findings of this review, based on our sample of selected Web of Science and Scopus articles, underscore that concrete research approaches to addressing climate change misinformation are explored across multiple domains. While geography education and its associated research have been at the forefront of integrating climate change education (Chang, 2023, 2024; He et al., 2024; Onuoha et al., 2021; Tabor & Harrington, 2023), concrete strategies to counteract climate change misinformation have not been explicitly incorporated into the discourse.

However, it is argued that geography education is uniquely positioned to address climate change misinformation, particularly in online environments where misinformation is most prevalent (McGrew, 2020; Osborne & Pimentel, 2023). Geography education's interdisciplinary nature stemming from its basis related to human–environment relations, spatial and temporal scales, and socio-scientific issues (Chang, 2023; Cresswell, 2013; He et al., 2024) provides a distinctive basis for integrating determinants of climate change misinformation components and intervention-approaches across the reviewed studies. To effectively counteract climate change misinformation, geography education may extend beyond isolated instruction on the causes and effects of climate change and instead adopt, in line with the notion of powerful knowledge, a deliberate integration of strategies for addressing misinformation (Chang, 2023). Such an approach entails the incorporation of intervention frameworks including media literacy, as well as inoculation- and debunking-based strategies (Allchin, 2023; Cook et al., 2023; McGrew, 2020).

Furthermore, students' access to powerful geographical knowledge is closely linked to the role of geography teachers (He et al., 2024; Mitchell et al., 2022). In particular, teachers' disciplinary agency and their capacity to align academic geographical instruction informed by the scientific consensus (Tabor & Harrington, 2023) with students' needs are critical for effectively integrating key determinants of climate change misinformation into geography education practice. To support this process and broaden teachers' professional horizons, it is essential to provide structured scaffolding that facilitates (He et al., 2024; Tabor & Harrington, 2023) the integration of interdisciplinary approaches and literacies enriching geography education discourse.

First, evidence on media literacy approaches highlights the potential for geography education to explicitly address how climate change is communicated, constructed, framed, distorted, and contested in online environments. Given that climate misinformation frequently circulates through social media platforms, visual content, and algorithmically curated information spaces, geography classrooms are well suited to critically examine these digital geographies (Fearnley, 2020; Roberts, 2020). Integrating practices such as civic online reasoning and lateral reading into climate change education enables learners to evaluate sources, assess credibility, and critically inquire into climate-related information (Allchin, 2023; Brodsky et al., 2021; McGrew, 2020). Geography education can thereby connect media literacy directly to climate framings, empowering students to become digitally literate and autonomous citizens (Roberts, 2020).

Second, the prominence of Nature of Science and epistemic determinant (Allchin, 2011) indicates that climate change education in geography education must foreground epistemic questions central to trust in scientific consensus, including learners' ability to evaluate scientific expertise. Geography education is uniquely equipped to address how scientific climate knowledge is produced (Tabor & Harrington, 2023), why uncertainty is inherent (Puttick, 2025), and how scientific consensus emerges across global research communities (Poor et al., 2025). Explicitly integrating epistemic

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notions into climate change education helps learners understand who counts as a credible expert in climate science, how scientific claims differ from opinion or ideology (Allchin, 2023; Anderson, 2011). This epistemic grounding is essential for counteracting misinformation that challenges the legitimacy of climate science in online and public discourse (Lewandowsky, 2021).

Third, the growing attention to psychological and affective dimensions suggests that effective climate change education in geography must address learners' emotional engagement with climate information (Chang, 2023). Online misinformation often appeals to fear and climate anxiety. Geography education can play a critical role in supporting learners' emotional resilience through hopeful, solution-oriented, and action-focused approaches (Arnot et al., 2024). By fostering self-efficacy and agency (Rushton et al., 2025), geography education can reduce susceptibility to misinformation.

Fourth, the findings on inoculation and debunking strategies (Schmid & Betsch, 2019) point to the value of explicitly preparing learners with strategies to identify deceptive misinformation techniques in advance. Climate change education in geography can integrate inoculation and debunking approaches, such as analyzing misinformation typologies (e.g., FLICC) (Diethelm & McKee, 2009) or using concrete case studies, within geographically grounded inquiries (Gold et al., 2015). When combined with media literacy and epistemic understanding, inoculation strategies enable learners to detect such claims persist in online environments (Roberts, 2020) and how they can be debunked. It contributes to an understanding of their origin in the context of broader socio-scientific issues at global scale (He et al., 2024).

Fifth, the findings on the lack of integration of AI and AI literacy as a major component in climate change misinformation interventions call for geography education to more explicitly engage with generative AI (Lane, 2025; Lee et al., 2025), for instance personalized large language models, recognizing their potential as tools for the personalized dispel of climate change misinformation and the development of understanding of mitigation strategies (Pearson et al., 2026; Remshard et al., 2026). At the same time, AI literacy needs to be integrated into geography education with regard to the critical evaluation of AI-generated content and the identification and dissemination of climate-related deepfakes (Doss et al., 2023; Vaccari & Chadwick, 2020), thereby extending traditional media literacy approaches. For geography education research, this calls for further investigation into how learners interact with AI-mediated climate information and how these interactions affect geographical understanding of climate change. Also, the need to integrate personalized interaction with AI to dispel prior erroneous climate change misinformation belief or repel climate change misinformation is of importance and currently lacking within the discourse. Thus, the findings of this systematic literature emphasize the crucial role of geography education and geography education research that climate change education must explicitly integrate the meta-lenses identified in this review to effectively counteract climate change misinformation, particularly in online environments. Geography education's capacity positions it as a central field for developing resilient, critical, and future-oriented climate change education. Finally, the findings suggest that integrating climate change misinformation into geography education requires a multi-theoretical and multi-dimensional approach. Addressing the identified blind spots particularly the lacking research on climate change misinformation within geography education, primary education, teacher education, Global South contexts, and AI-related misinformation is essential for strengthening educational resilience to climate misinformation. From a powerful knowledge perspective (de Miguel González, 2024; Lambert & León, 2026), geography education plays a crucial role in providing students with access to an understanding of critically engaging with misinformation, recognizing their civil rights, and acting as informed citizens in response to complex global challenges such as climate change (He et al., 2024).

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including deglobalisation, multipolar world orders, postcolonial critique, contested knowledge and places, and the integration of artificial intelligence in educational practice and research. The Special Issue is edited by **Dr Neli Heidari**, University of Bremen, Germany, **Dr Uwe Krause**, Fontys University of Applied Sciences, The Netherlands & Ege University Izmir, Türkiye, **Dr Susan Caldis**, Macquarie University, Australia, **Prof. Tine Beneker**, Utrecht University, The Netherlands, and **Dr Alexandros Bartzokas-Tsiompras**, National Technical University of Athens, Greece, & Associate Editor of the European Journal of Geography.

Contribution to the Special Issue Topics: The present study contributes to the special issue by systematically examining how geography education can respond to the epistemic challenges posed by climate change misinformation, exacerbated by marginalized gatekeeping and the rise of AI-generated content. Through a PRISMA-guided review of empirical research, the study identifies key trends, gaps, and implications for geography education, particularly regarding the potential of climate change education to foster resilience against respective misinformation. Thus, the study advances the special issue's mission to strengthen the societal relevance and transformative potential of geography education

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