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Can Education for Sustainable Development Support Climate Change Adaptation Effectively? A Delphi Study of Germany's Non-Formal Education Sector

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ABSTRACT

Education for Sustainable Development (ESD) aims to transform lifestyles and societal structures for a better future. Today, ESD often focuses on climate change (CC) and is widely considered as an important tool for empowering individuals for climate change adaptation (CCA). However, the effectiveness of ESD has scarcely been assessed empirically, especially in non-formal education. To address this gap, we conducted a Delphi study involving ESD practitioners from German non-formal education institutions. Our findings indicate that practitioners recognise the importance of ESD but think that it lacks coherence and needs further development, particularly in teaching CCA. Respondents identified various challenges, including the complexity of the topic and its association with 'dystopian' future visions. For successful CCA, respondents consider the ability to act, self-efficacy and motivation as crucial. We conclude that prioritising problem-solving skills and encouraging learners to reimagine social structures are essential for ESD to effectively contribute to society's CCA preparedness.

1 | Introduction

Adapting society to climate change (CC) is essential to reduce the vulnerability of natural and human systems and to maintain the conditions for people to live good lives. In this context, adaptation refers to the ability of systems to respond to climate change by remaining intact, limiting the negative impacts of change or even taking advantage of beneficial opportunities (IPCC 2023). This is all the more important because human civilisation is currently facing multiple severe environmental crises, including climate change, land-use change and land degradation leading to a massive loss of biodiversity and ecosystem services. Unfortunately, the target 'to limit the temperature increase to 1.5°C above pre-industrial levels' (UNFCCC 2015) and

prevent even more catastrophic consequences is receding in the face of the fact that global temperature has already reached 1.1°C above pre-industrial levels while greenhouse gas emissions are still growing (IPCC 2023).

In order to foster climate change adaptation (CCA), social actors need to know what environmental and socio-economic challenges CC poses, and they need to have the capacity to develop adequate strategies (Anderson 2012; Karidi, Schneider, and Gutwald 2018). However, education systems around the world are not yet adequately prepared for CC, its impacts and CCA (Fadel and Groff 2019). This is reflected by related knowledge deficits among young people (Bofferding and Kloser 2015; Graulich et al. 2021; Serra et al. 2022).

Abbreviations: CC, climate change; CCA, climate change adaptation; CCE, climate change education; ESD, Education for Sustainable Development.

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Education for Sustainable Development (ESD) is a globally recognised educational framework that addresses the interrelations between human societies and their natural environment on all levels from the local to the global. It was developed under the leadership of UNESCO based on the United Nations' Agenda 21 following the 1992 Rio Declaration on Environment and Development. To achieve the objectives of ESD, it is necessary to develop constructive responses to global problems and undesirable future scenarios including economic, ecological and socio-cultural aspects. Therefore, it is essential that people improve the competencies they need to tackle problems, understand connections and create strategies for action.

In order to bring ESD closer to practice, Gerhard de Haan (2008, 2010) has developed the concept of ESD-related *Gestaltungskompetenz* ('design competence'), which includes cognitive, emotional and social elements attributed to twelve component competences (Table 1).

The acquisition of *Gestaltungskompetenz* is intended to facilitate progress in all stages of development, while fostering attributes such as personal accountability, critical introspection, adaptability and intrinsic motivation (for a critical discussion see Anders et al. 2021). In this context, the purpose of ESD is to promote holistically transformative learning which involves a profound shift in personal attitudes, beliefs and behaviours that helps enable a more sustainable future (Edwards and Wiseman 2011; Lehtonen, Salonen, and Cantell 2019; Trott 2020).

ESD has been widely recognised as a potential means to prepare people for CCA, including young people (McNaughton 2012; Miller et al. 2022) as well as adult stakeholders and decision makers (González-Salamanca, Agudelo, and Salinas 2020; Leal Filho and Brandli 2016). According to the UNESCO (2020, 2023), ESD 'gives learners of all ages the knowledge, skills, values and

agency to address interconnected global challenges including CC, loss of biodiversity, unsustainable use of resources, and inequality' and empowers them 'to make informed decisions and take individual and collective action to change society and care for the planet'. Conceptually, Mochizuki and Bryan (2015) suggest that since 'CC encompasses environmental, political, social and economic factors, the holistic framework of ESD is an optimal framework to advance climate change education (CCE)'.¹ Assuming that ESD reaches many people and is relatively inexpensive, Anderson (2012) and Stevenson, Nicholls, and Whitehouse (2017) consider it one of the most important and effective avenues for CCE also in terms of practicability. By empowering individuals and communities to organise their resources and structures more effectively, they are better able to cope with the challenges of climate change (Feinstein and Mach 2020; Stoltenberg and Burandt 2014). In other words, ESD is about strengthening the ability to act—or capacity building, as demanded by the 1992 Rio Conference (UNCED 1992) and the Paris Agreement (UNFCCC 2015). Capacity building for CCA involves developing and strengthening skills, capabilities, processes and resources, as well as changing the mindsets and attitudes that communities need to navigate a rapidly changing world (Klinsky and Sagar 2022).

If education policy is to be based on it, then the common claim that ESD supports the development of CCA capacities effectively should be empirically validated. However, empirical support for this claim is missing, and there are also good reasons to doubt its underlying assumptions. Regarding the total impact that ESD could potentially achieve, it is worth noting that as of December 2023, only 1309 (German UNESCO Commission n.d.) out of a total of 99,800 (Autor:innengruppe Bildungsberichterstattung 2022) educational institutions in Germany were listed as ESD stakeholders, representing a mere 1% of the total. If one expects ESD to contribute substantially to developing society's CCA capabilities as a whole, then one probably expects too much from it at its current capacity. For

TABLE 1 | ESD-related *Gestaltungskompetenz* according to Gerhard de Haan (2010).

Classical competence terminology	Component competences of <i>Gestaltungskompetenz</i>
Subject and methodological competence	Gather knowledge in a spirit of openness to the world, integrating new perspectives Think and act in a forward-looking manner
	Acquire knowledge and acting in an interdisciplinary manner
	Deal with incomplete and overly complex information
Social competence	Co-operate in decision-making processes
	Cope with individual dilemmatic situation of decision-making
	Participate in collective decision-making processes
	Motivate oneself as well as others to become active
Personal competence	Reflect upon one's own principles and those of others
	Refer to the idea of equity in decision-making and planning actions
	Plan and act autonomously
	Show empathy for and solidarity with the disadvantaged

the future, one would need to call for a multiplication of the volume of ESD learning opportunities. As for empirical support on effectiveness, in an international literature review, Monroe et al. (2017) identified only a limited number of studies that shed light on the implementation and evaluation of CCE measures of any kind. Almost nothing is known about the effectiveness of ESD for CCA specifically.

While schools and universities have been assigned a major responsibility for ESD (Ashida 2023; Kolleck 2016; Sedlacek 2013), non-formal education could potentially play an important role, given that around 60%–70% of all educational processes in Germany take place outside formal schooling (BMBF n.d.). In this study, we define non-formal education as systematic and targeted education outside the formal curriculum, based on the definition of Germany's Federal Ministry of Education (BMBF n.d.). *Non-formal* education can take place in a variety of settings, such as museums, training courses or environmental education centres, and aims to enhance personal and social development, improving specific skills and competences (e.g., Thole and Hüblich 2014). It differs from *informal* education, which is mostly self-directed and based on individual interests and preferences, e.g. in typical case of public library users (Johnson and Majewska 2022). The non-restrictive design of non-formal education can be especially conducive to practice-oriented environmental learning (Hayden et al. 2011). The open and supportive atmosphere of out-of-school places can also encourage learners to question their beliefs, explore new ideas and actively shape their own development (Eshach 2007; Wilde et al. 2019). Such environments are particularly well suited to fostering transformative learning, an approach that refers to the process by which individuals, through critical reflection, challenge, change and broaden their perspectives and approaches, ultimately reshaping their worldview and behaviour (Mezirow 2000). Commonly used in ESD and CCE, transformative learning enables learners not only to acquire knowledge about complex issues, but also to develop the capacity to engage them critically (e.g., Taylor, Duveskog, and Friis-Hansen 2012). What is more, non-formal learning can have a positive impact on scientific interest (Neher-Asylbekov and Wagner 2023) and knowledge about CC (Trott and Weinberg 2020). This means that offering ESD for CCA in a non-formal setting could both take pressure off the formal education sector and be more effective at the same time.

Against this background, we conducted a Delphi study exploring ESD in Germany's non-formal education sector. We wanted to understand what potential, according to educators, ESD has in Germany's non-formal education sector for developing learners' capacities for CCA. The focus on Germany's non-formal education system is justified by its exceptional diversity and long history, compared to most other countries (Bolscho and Hauenschild 2006; Seybold and Rieß 2006). Hence, it makes an ideal case study. The fact that, to our knowledge, there are no comparable national-level studies on other countries only underlines the need for this research. Therefore, the aim of this study was to generate a wide range of findings that can contribute to the further development of national educational research and policy. Moreover, given the limited international research on this topic, the findings

from the German non-formal education sector can serve as a valuable reference for future studies and broader comparative analyses.

To address this overarching research interest, we sought to answer the following specific research questions:

1. To what extent and in what ways is CCA addressed in current non-formal education in Germany?
2. What are potentials and limitations for ESD in German non-formal education, particularly for teaching CCA?

We focused on understanding the challenges and lessons learnt for effective ESD in the context of CCA. In detail, these include, first, the challenges of integrating CC impacts and CCA in learning opportunities and, second, the lessons learnt regarding the skills, competences, knowledge and attitudes that are needed for effective ESD for CCA.

Overall, our study shows that practitioners in the non-formal education sector consider ESD to be an important tool for facing future challenges. However, practitioners' responses also suggest that ESD tends to lack coherence and needs to be improved, especially when it comes to teaching CCA strategies. The preference for teaching mitigation, as reported by the respondents, results in the neglect of adaptation as a topic and a failure to develop CCA capacities in ESD participants. Challenges in implementing ESD identified by respondents include the complexity of CC as a topic and its association with discouraging 'dystopian' visions of the future. Respondents consider the ability to act, self-efficacy and motivation to be essential for successful adaptation to climate impacts, with secondary value placed on design competence. We conclude that for ESD to make an effective contribution to society's CCA preparedness, it should prioritise problem-solving abilities and encourage learners boldly to re-imagine social structures.

2 | Materials and Methods

2.1 | Delphi Survey

To answer our research questions, we conducted a Delphi survey. The Delphi technique was first developed by Dalkey and Helmer (1963) and named after the Oracle of Delphi in ancient Greece, seeing as the original purpose of the method was to make predictions about the future based on expert opinion. To this end, Delphi studies are designed as a multi-stage, feedback-based survey process that collects a wide range of opinions and a large amount of information while focusing on essential aspects of a given topic (Cuhls 2019; Häder 2014). The questions for each round of the survey are based in part on the responses from the previous round, allowing the conversation to evolve over time (Barrett and Heale 2020).

There are several different approaches to conducting a Delphi study. The most common is consensus building (von der Gracht 2012). However, for the present research project, we followed the third Delphi study type as defined by Häder (2014), which serves to determine and qualify the views of a group of experts

on a diffuse issue. The aim here is to derive specific conclusions for necessary interventions, which allows the Delphi method to identify a need for further research.

One of the key aspects of the Delphi survey is that respondents remain anonymous, which is crucial to prevent individual participating experts from dominating the process and findings (Osborne et al. 2003). We ensured anonymity in two ways. Firstly, the survey was conducted online rather than in person. Secondly, the participants were given anonymised identifiers. Incidentally, conducting the Delphi study online also helped us to engage experts across Germany with minimal effort for the respondents while also eliminating any expenses of time and money that would otherwise be needed for travel, postage or digitising physical answer sheets.

As a multi-stage method, any Delphi study must include at least two rounds of questions and answers. Three or even four rounds have been recommended (Hsu and Sandford 2007). However, we were not looking for a consensus among respondents, which would indeed have required a longer process of communication, but for an overview of experiences, opinions and reactions to other perspectives. In this context, Häder (2014) found that the greatest change in expert judgements takes place between the first and second rounds. Hence, we proceeded with two rounds.

2.2 | The Expert Panel

For the expert panel of our Delphi study, we were looking to engage practitioners in non-formal education in Germany. We consider such practitioners to be experts for their field of practice (Bogner, Littig and Menz, 2014; Baur and Blasius 2014; Häder 2014).

Identifying experts in non-formal education in Germany proved to be challenging. The spectrum of non-formal education in Germany is extremely diverse, encompassing a range of programmes from early childhood education to adult education, taking place in different institutions specialising in specific age groups and subject areas. Furthermore, in Germany's federal system, while education is the prerogative of the states, non-formal education is carried out mainly by non-state actors (BMBF n.d.). As a result, any overview of non-formal education institutions in Germany remains incomplete. However, there is a comprehensive, although voluntary, ESD stakeholder map issued by the German UNESCO Commission (n.d.), which we used as a basis for selecting our invitees.

Given the considerable diversity of non-formal educational actors, we first restricted our scope to the 178 non-formal ESD institutions listed by the German UNESCO Commission's (n.d.). In addition, we set two further criteria. First, the actors should have at least three different thematic focus areas, potentially enabling them to provide interdisciplinary perspectives. Second, institutions had to directly engage with learners, ensuring that our expert could address practical aspects from firsthand experience. Consequently, we excluded institutions that were only active in an advisory capacity or only produced educational materials. Finally, a sample of 106 institutions across Germany was identified for participation in the survey.

The institutions in the sample were informed in advance about our framework and survey procedure. Once the institutions had agreed to participate, invitation links with individual access details were sent. Only one participation per institution was possible.

Our analysis is based on the responses of those experts who provided complete answers to all our questions. They collectively represent 21 non-formal education institutions, or approx. 20% of the invitees, in 13 (out of 16) German states (Table 2). The topical foci of these institutions were quite heterogeneous, ranging from development policy, environmental education, sustainability projects and consulting to forest pedagogy and outdoor education programmes. For qualitative Delphi studies such as ours, this number of participating experts is considered sufficient (Akremi 2014; Häder 2009).

2.3 | Delphi Rounds and Qualitative Content Analysis

The first Delphi round was conducted at the beginning of February 2023 using a standardised online questionnaire with 49 questions (Appendix S1) realised in the LamaPoll software (Lamano GmbH and Co. KG 2022). The questionnaire was drafted by the first author and discussed and refined with the second and third authors of this article. While there were no previous studies on the same topic to draw on for the development of the questionnaire, existing literature on topics such as the challenges in integrating climate education served as partial guidance (e.g., Liu et al. 2015).

Four types of questions were used: (1) qualitative questions with open answers, (2) quantitative questions with three possible answers, (3) questions with answers according to a 5-point Likert scale and (4) rating questions with a sliding scale to indicate agreement or disagreement with a statement. We used the qualitative questions to generate opinion patterns and the quantitative questions to further disaggregate these data. As is typical of the first round of a Delphi study, the focus was on qualitative aspects, which is why a significant number of questions were open-ended. In the second round, questions became more quantitative, including an increased use of rating techniques (Powell 2003).

The questionnaire for the first round covered five main thematic categories: (1) CC and its impacts in general, (2) the 1.5° target, (3) CCA, (4) resilience and (5) ESD. As a starting point (1), the questionnaire assessed participants' overall understanding of CC and potential climate impacts, with the particular aim of learning which climate impacts they considered most important and whether they estimated the current climate targets to be realistic (2). We partly interpreted these answers to indicate how aware and open-minded respondents are regarding CCA. This was followed (3) by specific questions on participants' knowledge of strategies for CCA, how their institutions address this topic, and what challenges to implementation they perceive. Additionally (4), experts were asked if and how they implement resilience strategies in their institutions. Given that the literature often associates CCA with resilience, this concept could be a promising approach to developing

TABLE 2 | Characterisation of the (anonymised) participants (PA1- PA21) of the Delphi study as representatives of the non-formal education sector in the federal states of Germany.

Participant	Federal state	Self-identified educational focus of participating institutions	Delphi rounds
PA1	Baden-Württemberg	Global learning	1 + 2
PA2	Baden-Württemberg	Forestry pedagogy	1 + 2
PA3	Baden-Württemberg	Public adult education	1 + 2
PA4	Baden-Württemberg	ESD, environmental education	1 + 2
PA5	Berlin	ESD, environmental education	1 + 2
PA6	Berlin	Volunteer services	1 + 2
PA7	Brandenburg	ESD in education offers	1
PA8	Bremen	Adult education	1 + 2
PA9	Hesse	Outdoor education centre	1 + 2
PA10	Hesse	Sustainability projects and consulting	1
PA11	Lower Saxony	General education, scientific research, soft tourism	1 + 2
PA12	Mecklenburg-Western Pomerania	ESD, support for future processes	1 + 2
PA13	North Rhine-Westphalia	Democracy education, transformative education, antiracism work	1
PA14	North Rhine-Westphalia	ESD and climate education, research, education advocacy	1 + 2
PA15	North Rhine-Westphalia	ESD	1 + 2
PA16	Rhineland- Palatinate	Person-centered political education	1 + 2
PA17	Saarland	Farm, nature and wilderness pedagogy	1
PA18	Saarland	Self-efficacy	1 + 2
PA19	Saxony	MINT subjects, ESD in extracurricular children and youth work	1 + 2
PA20	Schleswig-Holstein	Sustainable climate protection	1 + 2
PA21	Thuringia	Development education work, ESD	1 + 2

Abbreviation: ESD, Education for Sustainable Development.

strategies for CCA. Finally (5), we asked participants if they considered CCA to be part of ESD. The aim was to compare information from the literature with the beliefs held by those working in the field. Given the diverse backgrounds of the interviewees, we also provided a brief overview of relevant topics at the beginning of each chapter. This included consensus definitions of CC and CCA (IPCC 2018, 2021), as well as additional literature (BMUV n.d.; Grothmann et al. 2011) and journalistic pieces (e.g., Quarks 2019). This approach ensured that all interviewees had a common understanding of the terminology and concepts used in both questionnaires.

Experts' answers from the first Delphi round were analysed in two steps. Quantitative responses were analysed by means of descriptive statistics using arithmetic means and frequency distributions. Qualitative responses underwent deductive-inductive qualitative content analysis (Mayring 1994; Kuckartz 2019) using the software *f4analyse* (cp. Somme and Hajart 2019). The advantage of qualitative content analysis lies in its detachment from the text as a whole. Only information relevant to

the research questions is considered in further processing; at the same time, the information remains in context (Gläser and Laudel 2010).

Our qualitative content analysis proceeded in six steps (Figure 1). Initially, the main categories were deduced in alignment with the pre-established categories of the questionnaire. Next, the findings were coded into these main categories. Subsequently, sub-categories were developed, and the codes were split into smaller sub-codes: practice; advantages and disadvantages of non-formal education; challenges and opportunities; and dealing with CC. Coding was conducted by the first author of this article. In preparation for the second round, the results based on the coding scheme were summarised.

The second Delphi round took place in mid-March 2023. Based on the feedback from the first round, we asked respondents to complete a questionnaire with 41 questions (Appendix S2). 17 of the 21 participants (81%) completed the second survey. Based on insights from the first round, the themes in the second survey

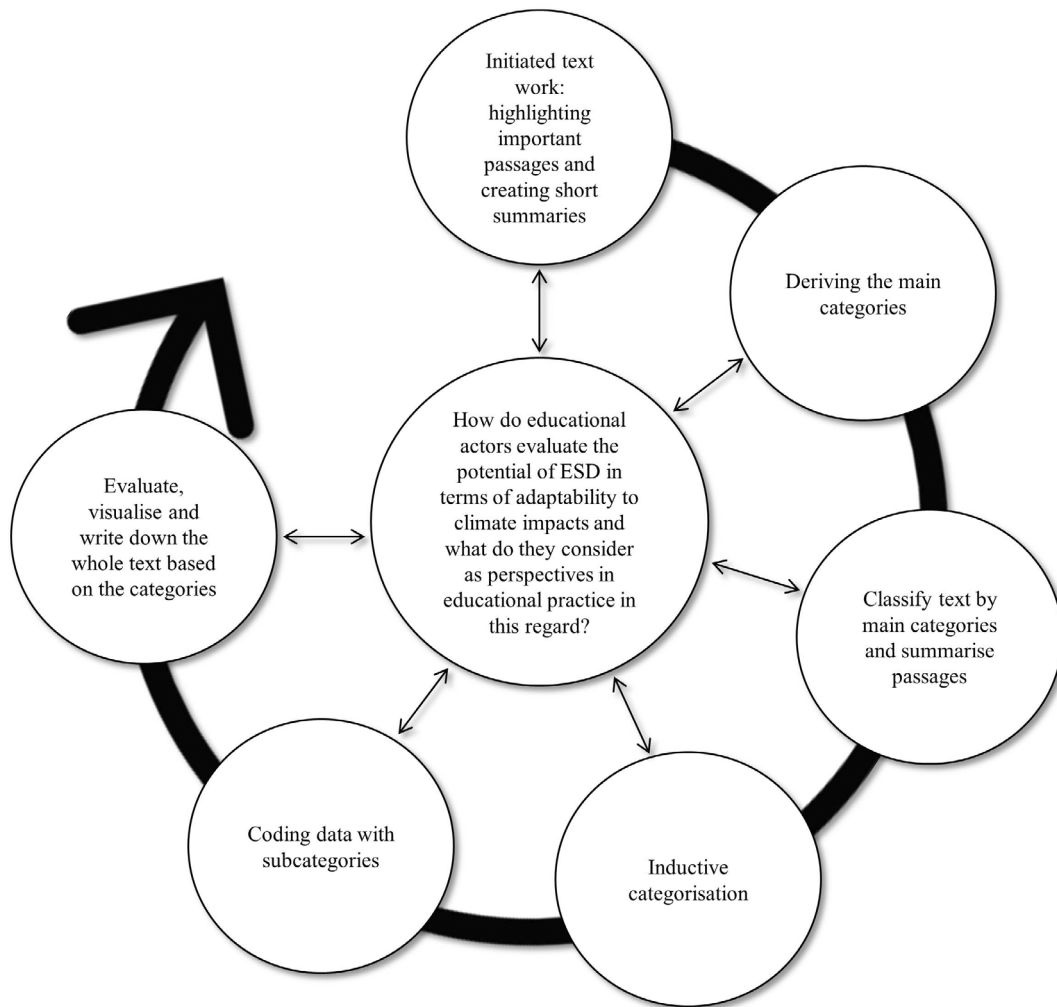


FIGURE 1 | Process of the qualitative content analysis in six steps (according to Kuckartz and Rädiker (2022) adapted).

were limited to ESD and CC. However, this time, we used a greater proportion of quantitative questions and rating tasks. Experts were invited to comment on findings from the previous round and to suggest modifications to previous answers, both their own and other respondents'. The analysis of their input followed the same approach as in the first round. This time, the CC category was divided into three subcategories: climate impacts; strategies for CCA and compatibility with sustainable development; and CC mitigation measures. The ESD category was divided into four subcategories: impacts; conflicting objectives and solutions; conceptualisation; and dealing with CC.

Finally, the results of both rounds were summarised synoptically.

3 | Results

While the surveys elicited a rich collection of responses regarding the impacts of CC and strategies for CCA, they yielded only limited information on educational practice, with the second round providing a slightly more detailed account. According to respondents, ESD is a multifaceted educational concept that involves different disciplines and audiences. It requires exchanging ideas and opinions while maintaining a positive attitude despite negative scenarios to encourage individuals. A more

standardised approach is necessary for climate education to be effective and motivate individuals to act.

3.1 | Respondents' Perceptions of Climate Change, Mitigation and Adaptation

The majority of respondents (19 out of 21) consider it improbable that humanity will manage to limit global warming to 1.5°C above pre-industrial levels. On average, respondents rated their expectation at 24 points on a scale ranging from 0 (very improbable) to 100 (very probable), reasoning that mitigation measures so far have been insufficient and inconsistent, especially politics and the economy. Only in outlier cases did respondents offer confident statements such as this: 'I believe in the young generation and its creative power, and I hope that we will soon see a surge in innovation in the communities' (PA9).

Regarding the expected consequences of CC, responses may be grouped under the three headings of ecological, economic and social. Expected ecological consequences include drought, storms, extreme heat periods, natural hazards, rising sea levels, increased fires, desertification and the loss of biodiversity. Expected economic consequences include poverty caused by crop failure, increased costs of living, unemployment and

inflation. Many of the respondents argued that increasing environmental damages and crop failures would lead to economic and financial crises. Against the background of these negative consequences, two experts also pointed to positive aspects such as the decarbonisation of industries and the decentralisation of food supply. Expected social consequences of CC include inequality, migration, political conflicts, change of living conditions, selective overpopulation, health problems and resource depletion. In the second round of questions, we asked the participating experts explicitly whether they believed that CC could also have positive effects. In response, more than half stated that CC can indeed promote positive developments (Figure 2).

One point of consensus among respondents was the necessity of strategies for CCA. It is necessary to seek future changes in various industrial, ecological and social domains. At the same time, strategies for better CCA must be established. Responses to the question which strategies they consider to be of general importance differed widely.

Regarding the adaptation of agriculture and nutrition, respondents highlighted agri-transformation (in German 'Agrarwende'), the promotion of regional products, and the breeding of climate resilient plants. For ecological adaptation, respondents pointed to a wide variety of strategies including reforestation, rewetting of peatland, restoration of rivers and groundwater protection.

Regarding infrastructure and the development of settlements, respondents suggested surface unsealing, stormwater retention, air filters and innovative urban development concepts. They also highlighted protection against extreme weather events and flooding. Three respondents pointed to the need for a continued energy transition (in German: 'Energiewende') with a focus on renewable energy and the sanctioning of climate-harming actions. In terms of mobility, two respondents suggested car-sharing concepts.

Regarding social adaptation, respondents said that both education and healthcare need to be reformed, with healthcare focusing on prevention and protection against pandemics and new diseases. Respondents also mentioned that people need to rethink their recreational behaviour since travel vacation will be a 'luxury' in the future. Two respondents questioned the future of capitalism and suggested a renunciation of profit

so that 'the social valuation would no longer be defined by monetary values' (PA4).

Asked what they consider more important, the mitigation of or the adaptation to CC, most respondents opted for mitigation in both survey rounds. Only one respondent clearly changed their opinion. Eight respondents consider both to be equivalent: 'In fact, climate impacts are inevitable and adaptation to them must be addressed accordingly. At the same time, climate change mitigation is necessary to maintain a liveable and viable world' (PA16).

We also asked respondents to comment on an apparent contradiction in their answers from the first round: On the one hand, they recognise that society is impacted by CC and adaptation measures are necessary. But on the other hand, they consider mitigation to be more important. Respondents did not accept this as a contradiction. Interestingly, some interviewees pointed out that a focus on the consequences of CC and CCA strategies might overlook the causes of CC.

However, some explained that adaptation measures are easier to implement than the social changes needed for mitigation (so more effort needs to go into the latter). The assumption that this reasoning might be shared more generally is supported by the fact that slightly more than half of the respondents (59%) believe that mitigation measures are primarily associated with restraint and renunciation. The hypothesis that respondents associate strategies for CCA more strongly with technological innovations could not be confirmed (Figure 3).

3.2 | Common Potentials and Limitations of ESD

In general, responses were notably vague when it came to defining the concept of ESD, in the first round of the study (Figure 4). Confronted with this result in the second round, 65% of respondents answered that they and their peers keep explanations short and vague because they lack detailed knowledge about ESD: 'I personally find it difficult to concretise ESD in the different areas of education, to identify the necessary transformation approaches or to describe the exact mode of action—I can imagine that many others do this as well' (PA14). This is underlined by another statement: 'In my opinion, ESD as a concept is not yet fully and conclusively developed' (PA21).

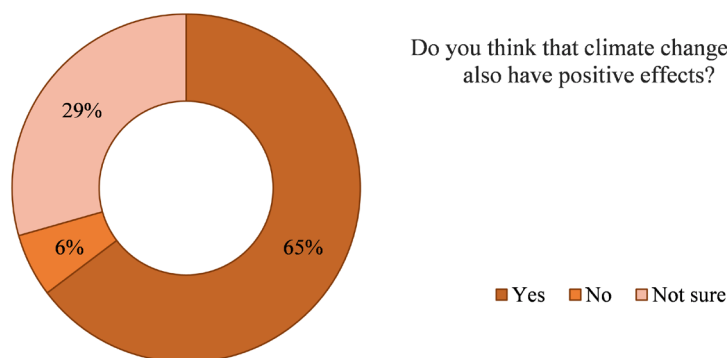


FIGURE 2 | Percentage of respondents to the question of whether they think that CC can also have positive effects.

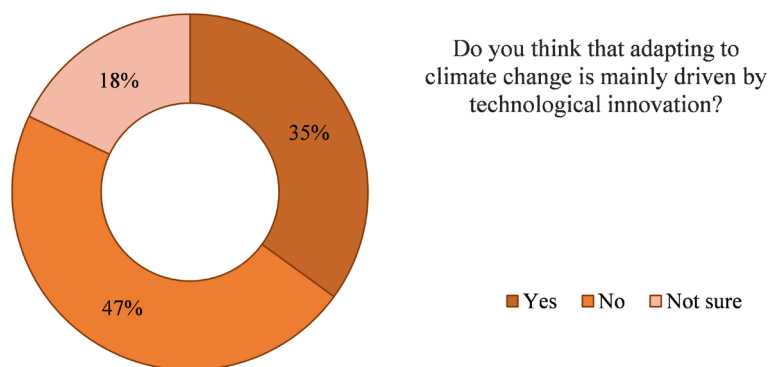


FIGURE 3 | Percentage of respondents who answered the question whether strategies for CCA are primarily developed through technical innovations.

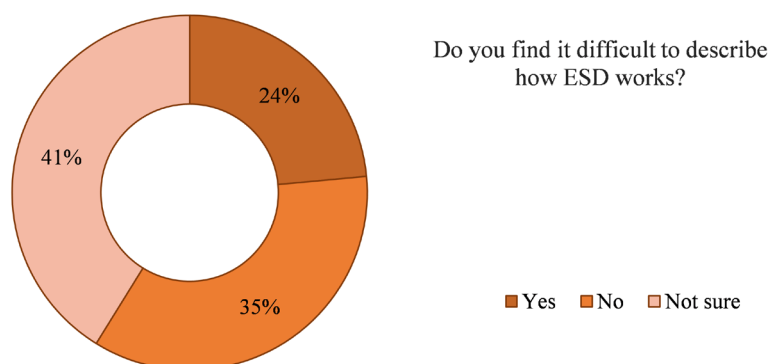


FIGURE 4 | Percentage of respondents to the question of whether they find it difficult to articulate how ESD operates.

Perceiving ESD as a relatively new field of education, many stakeholders find it difficult to articulate its tasks and mechanisms precisely. The complex nature, global dimensions and topicality of ESD require a high level of understanding and it is often difficult to communicate multi-perspective discourses and dynamic developments. The difficulty of defining ESD was highlighted by the fact that some stakeholders equate ESD with environmental education.

Respondents see difficulties not only in defining and articulating ESD, but also in practice. 60% think that more needs to be done here: 'For the middle of society, ESD is still a closed book. It is too often too schematically structured and not practical enough when we work together in (supra)regional bodies' (PA20). The respondents consider it particularly important to standardise approaches and to embed ESD more widely at different organisational levels. However, some of the interviewees point out that this is difficult, as ESD practices may need to be adapted according to the age group and receptiveness of the audience, adding further complexity.

However, opinions diverge. Seven respondents (33%) consider ESD to be a successful concept and emphasise its adaptive potentials. According to them, ESD reaches many different target groups and produces inquisitive, analytically minded learners with a developed ability to act on their knowledge. In addition, ESD can trigger transformation processes, increase awareness for sustainability topics and contribute to sustainable mindsets and action. It offers a holistic approach across individual, institutional and societal levels.

To enhance ESD, Gerhard de Haan (2002) has developed the umbrella concept of *Gestaltungskompetenz*. We asked respondents to rate the importance and difficulty of integrating its component competences into ESD (Figure 5). On average, 'Think and act in a forward-thinking manner' and 'Integrate ideas of justice into decisions and actions' were rated as the most important competences, and less than one third of respondents considered them difficult to integrate. However, many found the competence 'deal with incomplete and overly complex information' difficult to implement (average = 48%), despite it being moderately important (average = 24%). In certain cases, promotion was considered equally important and challenging, such as 'plan and act autonomously' and 'motivate oneself as well as others to become active'.

In explaining their choices, respondents most often emphasised the importance of strengthening agency and self-efficacy to motivate people to act and bring about change. They considered collective action necessary to overcome crises and to deal with the negative effects of climate change. Regarding difficulties in strengthening ESD-related competences, respondents mentioned learners' weak personal connection to the issues and their low self-efficacy. This was emphasised more often; for example, 'Students feel that they can only stand by and watch as society rushes into a crisis that is not of their making' (PA1). In addition, respondents surmised that CC-related problems often lack the immediate urgency for learners to feel prompted to action. Motivating emotions and values are difficult to teach. Respondents further reported that young people often seem pre-occupied with their particular social world and show little interest in other issues.

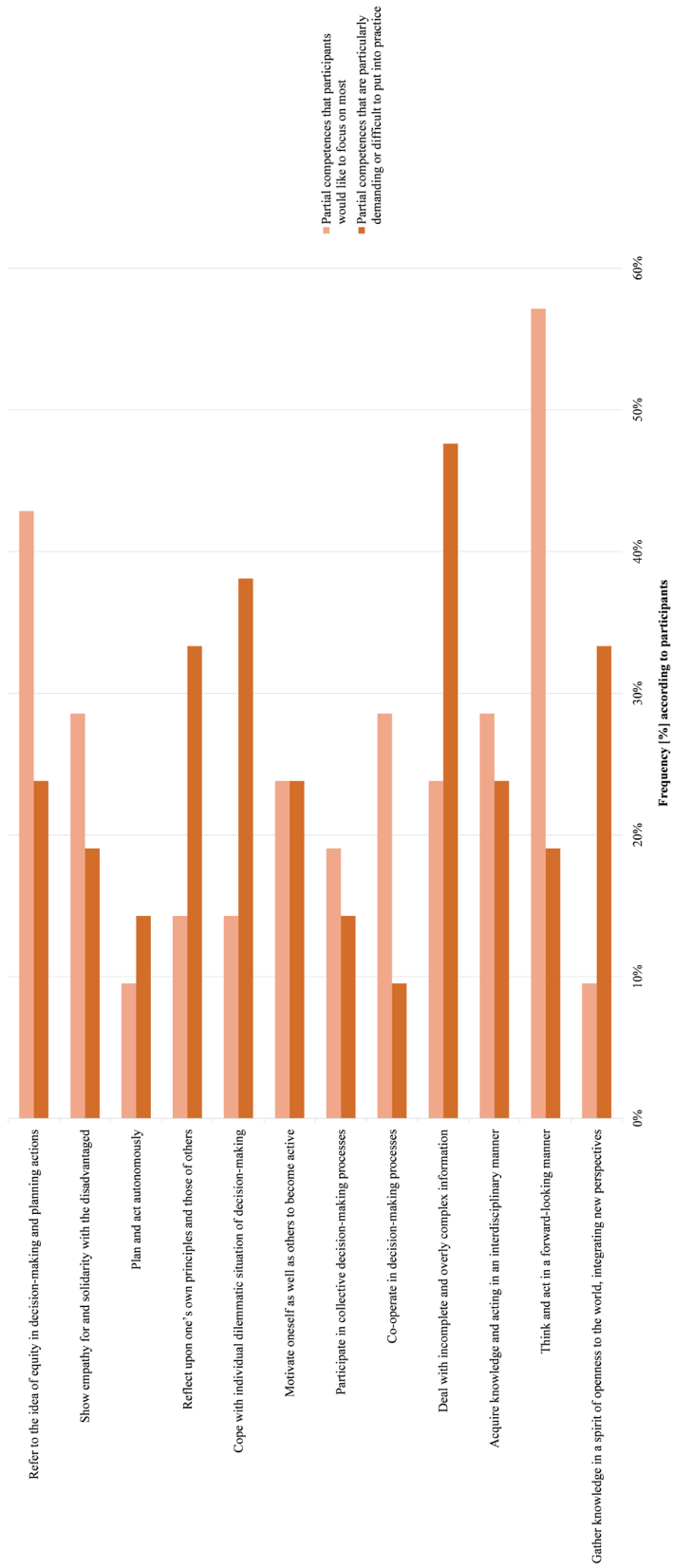


FIGURE 5 | Assessment of the ESD-related Gestaltungscompetenz according to De Haan (2010) taught within ESD.

3.3 | Benefits of Non-Formal Education Settings

More than half of the respondents (57%) see more benefits in providing ESD in non-formal educational settings than in formal institutions such as schools. In the second survey round this agreement even increased to 66%. According to respondents, the non-formal sector can operate more freely, spontaneously and diversely, thus promoting independent learning. In general, participants are more willing and motivated to learn because they feel intrinsically interested and not extrinsically pressured to perform. Another advantage of non-formal education is that, typically, learning topics and environments are thematically aligned and offer a hands-on experience. In particular, the real-world relevance and interdisciplinarity of non-formal education on important and complex issues can help participants to develop strategies for CCA. As one respondent noted, ‘using interactive and motivating methods, learners collected ideas [...] on the climate protection measures that the public and business sectors should implement’ (PA1).

3.4 | The Potential and Challenges of Integrating CCA Into ESD

CCA strategies are seen as part of sustainable development by the majority (more than 80%) of respondents. Respondents see ESD as important for communicating CCA. In the first round, this was confirmed by 95%. In the second round, however, this percentage dropped to around 70%. As one respondent

commented: ‘Actually an important factor, but even more important is appropriate (global) policy’ (PA10).

Regarding the potential of ESD for CCA, respondents said it could promote a sense of responsibility, support changes in individual behaviour and stimulate critical thinking. Through experienced-based knowledge and holistic and multi-dimensional learning approaches, learners could better understand the complex subject matter of CC. Interestingly, respondents pointed out that ESD could also motivate and enable people to develop individual CCA strategies.

It is therefore not surprising that 80% of respondents stated that strategies for CCA are discussed in their institution (Figure 6). However, they describe its importance in daily work as minor (Figure 7). Only one respondent indicated that strategies for CCA account for around 70% of their daily work. About 90% of respondents confirmed that ESD as practised in their institutions should give CCA-related topics much more space.

Respondents perceive dystopian future visions as one of the major obstacles resulting in demotivation and fear, particularly among young people. More than half of respondents think that learners can quickly feel overwhelmed by the issues of CC and CCA (Figure 8). It is widely emphasised that one of the reasons for this is that the consequences and interrelationships of global warming and sustainable development are complex, and it is difficult to convey multi-perspective discourses and dynamic developments in the educational formats available for ESD.

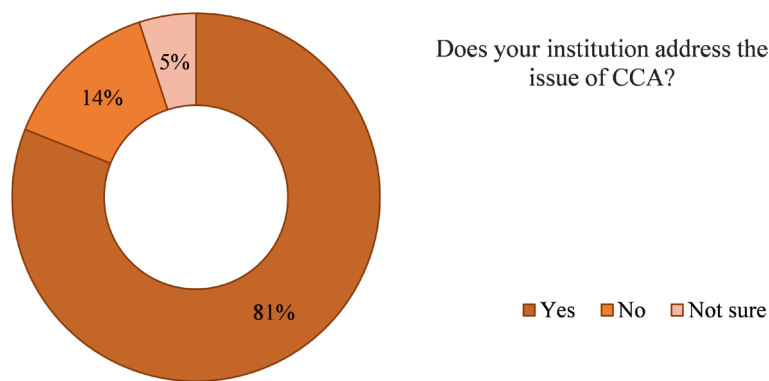


FIGURE 6 | Percentages of different responses to the question, ‘Does your institution address the issue of CCA?’.

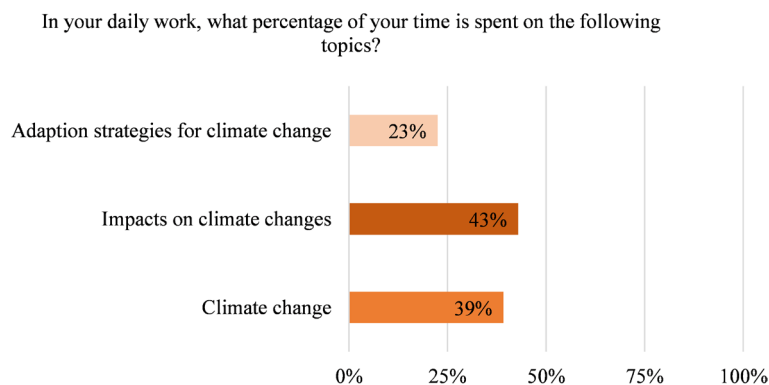


FIGURE 7 | Mean percentages of daily work time respondents say they spend on CC, CC impacts and CCA strategies, respectively.

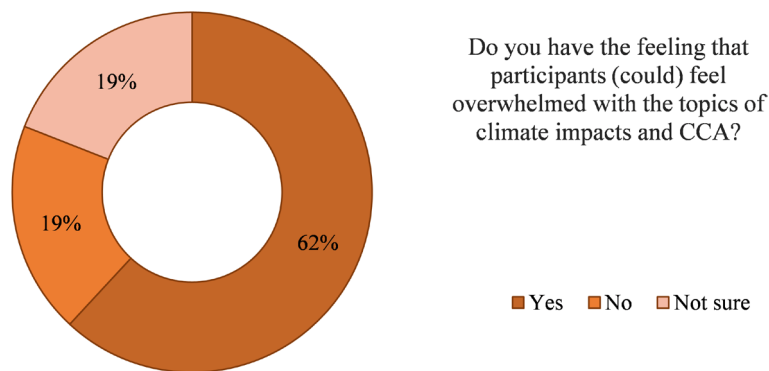


FIGURE 8 | Percentage of responses to the question if participants may feel overwhelmed by the topics of climate impacts and adaptation to climate impacts.

Furthermore, if only the facts are presented, it seems hopeless: ‘Because too little is being done and too slowly. Unfortunately, not only in Germany, but also in other countries, too little is being done to protect the climate and the environment’ (PA5). For individuals in particular, the question often arises: ‘What could I do that would make a difference?’ (PA12). Respondents also worry that discussing adaptation strategies might lead to neglecting the causes of CC.

4 | Discussion

If the respondents in this study are in any way representative, then there seems to be consensus among practitioners that ESD should address CC, including possibilities of mitigation and adaptation. In this regard, our findings concur with previous studies (cf. Barth, Michelsen, and Sanusi 2011; Nomura and Abe 2009). Given that we could find no previous data on the extent to which climate issues have been integrated into ESD practice, it may come as a surprise that more than 80% of the participating institutions from Germany’s non-formal education sector already do so. Respondents showed themselves to be well-informed about climate issues. This picture differs remarkably from the findings of related studies on the formal education sector (Fadel and Groff 2019; Monroe et al. 2017; Serra et al. 2022). As a caveat, self-selection of participants may skew the results of our study.

4.1 | Integrating CCA

In alignment with the findings of Bofferding and Kloser (2015) and Ratinen (2021), our respondents believe that mitigation is more important than adaptation, and this is reflected in their educational practice. While CC causes, impacts and mitigation are the topic of 40% of our respondents’ daily work, only 20% is dedicated to CCA. Against this background, what would need to be done to integrate CCA further into ESD? Several challenges are apparent from what respondents told us.

One challenge is the risk of overstraining and scaring learners. CC perceptions have been shown to impact mental health and general wellbeing (Cianconi, Betrò, and Janiri 2020; Schwaab et al. 2022). At the time of writing, the mood among sections of Germany’s population, including climate activists of the ‘Last Generation’ and their sympathisers, seems to be turning

increasingly apocalyptic. Hence, the emotional effects of CCE education should be considered, particularly when addressing younger learners (Hickman et al. 2021). At the same time, better to understand CC issues can help learners find a constructive attitude and maintain emotional balance (Hamann, Baumann, and Löschinger 2016; Li and Monroe 2019), motivating them to take individual or social action for climate protection and CCA (Lotz-Sisitka et al. 2015; Monroe et al. 2017).

The main constraint to conducting any kind of ESD in the non-formal education sector is limited financial and human resources (cf. Holz and Stoltenberg 2011; Vey 2015). Furthermore, coming to grips with the complex subject matter and developing appropriate learning units seems to be beyond the current capacity of many institutions of non-formal education (Adamina et al. 2018; Reid 2019). What is more, qualitative responses point to deficits in practitioners’ personal understanding of climate-related topics, including the confusion of mitigation and adaptation strategies. Educators’ knowledge deficits will likely be passed on to learners (Graulich et al. 2021). This is a structural problem in the German educational landscape (Brock and Grund 2018) as well as internationally (e.g., Liu et al. 2015; Kamenetz 2019). On the other hand, educators’ self-efficacy correlates positively with students’ intentions to adopt sustainable behaviour (Scharenberg et al. 2021).

In conclusion, practitioners in ESD for CCA need specific training to remedy current deficits in knowledge and methodology. Additionally, institutions need better funding to develop adequately qualified personnel and learning concepts while also ensuring the cost-effectiveness of education, thus enabling its accessibility to a broad population.

4.2 | What Needs to Be Taught

Our results do not show any tendency as to which thematic focus should be placed on the integration of adaptation strategies. Responses regarding specific content were rare and quite diverse. This may be a consequence of the orientation of educational institutions and the specificity of the target group, which makes it challenging to narrow down and generalise.

Among the ESD-related component competences of *Gestaltungskompetenz* (De Haan 2008, 2010) that respondents

TABLE 3 | Key competences which are considered important for the development of CCA strategies in ESD.

	Function related to adapting strategies	Challenges
Motivation	Conviction and a willingness to create and commit to something are the basis for changes in behaviour. Strengthening motivation is therefore the basis for implementing adaptation strategies	<ul style="list-style-type: none"> • May be inhibited by low perceptions of self-efficacy and agency. • Is influenced by climate anxiety and a sense of being overwhelmed.
Self-efficacy	Realising that a challenge can be overcome by one's own efforts increases both motivation and willingness to act. Self-efficacy is crucial for adaptation to climate impacts, as people feel empowered by a stronger self-efficacy to adapt better to an unforeseen situation	<ul style="list-style-type: none"> • Societal and political boundaries that lead to scientific demands and findings not being considered by those in positions of power, thus devaluing the perception and impact of one's own actions. • The complexity of climate impacts can feel overwhelming, so that effective action is not recognised.
Capacity to act	Awareness of one's own impacts and one's own capacity to act and respond encourages active participation. Capacity to act is crucial for the development of adaptation strategies, as it describes the ability of those affected to respond and adapt to climate impacts.	<ul style="list-style-type: none"> • Lack of resources and information limits awareness, so that capacity to act is not recognised • Uncertainty and complexity of impact and scale hinder the development of agency.

in our study considered important, there is a considerable spread when it comes to the perceived difficulty of teaching them (Figure 5). Respondents found competences such as 'thinking and acting in a future-oriented way' relatively easy to teach, perhaps because they are partially amenable to the same teaching methods as some more traditional competences including problem-solving and critical thinking. In contrast, respondents found the competence 'understanding goal conflicts in action strategies' relatively difficult to teach, probably because learners need to understand the causal and evaluative complexity of a situation before they can even identify most goal conflicts.

However, respondents rarely mentioned competences on their own accord. Based on their answers to open questions, what contributes most to successful ESD for CCA is learners' active participation and positive attitude, including confidence in their own abilities and the conviction that they can make a difference. This assessment aligns with research indicating that learners' behaviour is influenced by problem-solving training and specific actionable options (Li and Monroe 2019; Stevenson, Nicholls, and Whitehouse 2017). Based on these findings, three new overarching competences have been identified that should become more central both in education in general and in ESD for CCA in particular (Table 3).

If agency, participation and self-efficacy are as central competences for CCA as this study suggests (also see Kolenatý, Kroufek, and Činčera 2022), future research should explore how ESD for CCA could be designed to strengthen them (cf. Rousell and Cutter-Mackenzie-Knowles, 2020). This is just one of several promising avenues for further investigation.

Another area that deserves greater attention is capacity building, defined as the process of acquiring, adapting and

expanding skills and competences to shape one's own development sustainably (Klinsky and Sagar 2022). Respondents in our study identified capacity building as a key factor alongside knowledge growth and the development of teaching-learning settings. Nevertheless, our findings identify two major challenges in this area. First, educators must possess the capacity to develop sustainable development competences in themselves and support in others in doing the same. This can be achieved by integrating these competences into teacher training and curriculum development in the formal education sector (Potthast et al. 2018; Rieckmann and Barth 2022). However, non-formal education does not have mandatory training requirements (BMBF 2008; Mayombe and Lombard 2016). As a result, there is a lack of qualified trainers, change agents and multipliers (Wals, Mochizuki, and Leicht 2017). Secondly, there is a lack of long-term and holistic training. However, it is crucial that capacity-building initiatives not only focus on the transfer of short-term knowledge, but also encompass long-term and continuous support (Wals 2015). To ensure the sustained efficacy and impact of educational initiatives, a strategic and forward-thinking approach to planning and resource allocation is necessary.

The discussion on capacity building leads to another important aspect: the integration of competences into practical contexts and how to effectively teach them. Further research should develop concrete learning models based on our findings. One possible approach would be to develop a model based on Pettig's (2021) framework, with a particular focus on problem-solving and the competences identified in this study. The conceptual framework could also benefit from further grounding in related approaches such as inquiry-based learning (e.g., Pedaste et al. 2015). Furthermore, backcasting starts from a vision of the future and then explores in reverse time, as it were, what would need to have happened to

realise this future (Quist and Vergragt 2006; Robinson 2003; Robinson et al. 2011). This could be a very valuable method both in the training of educators and in ESD for CCA, and further research should consider how to apply and adapt it for this purpose.

4.3 | The Role of Non-Formal Education

The responses of the experts who participated in our study confirm that the non-formal education sector holds great potential to support climate change adaptation through Education for Sustainable Development. Even though respondents rate mitigation as more important, all agree that adaptation is necessary. There is also widespread agreement that ESD is the best available framework for developing CCA capacities, if only 'because there are no meaningful competing concepts' (PA21).

Compared to the formal education sector, institutions of non-formal education are far more flexible and agile when it comes to adapting their programme and educational methods (e.g., Affeldt et al. 2017; Johnson and Majewska 2022). They find it easier to create spaces for independent learning, possibly supported by open educational resources (Kim, Lee, and Park 2019; Ponti 2014). Furthermore, other education sectors, such as formal institutions, can also benefit from non-formal education work. The studies by Trott and Weinberg (2020) and Neher-Asylbekov and Wagner (2023), among others, demonstrate that this approach can result in positive synergies.

However, non-formal education only reaches those who are interested. Time constraints and lack of financial resources often mean that ESD is not fully implemented in non-formal education settings that its topics cannot be explored and addressed in the necessary holistic manner. Limited prior knowledge and the diversity of participants also make it challenging to tailor educational offerings to the target audience effectively. This suggests that ESD for CCA in Germany could benefit if professional development of its practitioners were improved and non-formal education were more adequately funded.

5 | Conclusion

Can ESD support CCA effectively? Our Delphi study with experts from Germany's non-formal education sector suggests that it can if it focuses on strengthening learners' agency, participation and self-efficacy, which were identified as core competences for CCA.

Overall, both our respondents and many writers on the topic agree that ESD is a suitable framework for developing learners' CCA capacities. However, ESD for CCA can arguably be more effective in non-formal settings than in formal ones. Non-formal education can be more flexible, adaptive and open-ended, promoting independent learning and hence CCA core competences. In addition, and presumably because of these same qualities, institutions of non-formal education seem to find it easier to integrate any kind of ESD into their programmes.

Another finding of our Delphi study is that there is a large gap between the possession of knowledge and its use in ESD. Even where respondents both have a considerable amount of knowledge on CC issues and support a greater focus on CC and strategies for CCA in ESD, this hardly shows in their educational practice. This may be partly explained by the fact that they generally consider mitigation to be more important than adaptation, but they may also lack some of the necessary concepts and skills to integrate CCA competently. In response, training ESD practitioners specifically in CCA could contribute to the quality of such courses where they occur, as could better funding for institutions of non-formal education to free up work time for course and personnel development and expand their reach (cf. Leal Filho et al. 2021). However, to make a significant impact on society's overall CCA capabilities, ESD for CCA would probably have to reach many times more than the current total number of learners. That said, there is clearly a demand that is not being met. For instance, Brock and Grund (2018) found that young adults would like to see three times more ESD content in non-formal education than is currently available.

Further research could not only help develop appropriate guidelines for ESD for CCA and concrete learning units that target different groups of learners, as well as improve the conceptual framework including a more practical ESD competence model. It could also be instructive to conduct further Delphi studies on the same subject matter but using different expert panels and analysing results in relation to, for example, age, gender, education level, target group and cultural background (cf. Hussler, Muller, and Rondé 2011). In addition, a larger number of respondents could lead to more robust results (Häder 2000).

Our Delphi study is limited to Germany, and so is the generalisability of its findings. Including more countries was beyond our resources. To understand the situation and potential of ESD for CCA elsewhere and ultimately worldwide, we encourage further research including additional country studies, comparisons and syntheses.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

Endnotes

¹ While there is an important international literature around the terms 'climate change education' and 'climate literacy' (e.g., Azevedo and Marques 2017; Milěř and Sládek 2011), the same subject matter is usually subsumed under ESD in German government publications and the education systems of German-speaking countries (Holst and Brock 2020). We follow this usage here. Whether classified as a sub-field of ESD or not, CCE focuses on the knowledge and skills that people need to address climate change (UNESCO 2020, 2021).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.