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EdTech for Climate Resilience

A Rapid Evidence Review

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Reviewers

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About EdTech Hub

EdTech Hub is a global research partnership. Our goal is to empower people by giving them the evidence they need to make decisions about technology in education. Our evidence library is a repository of our latest research, findings, and wider literature on EdTech. As a global partnership, we seek to make our evidence available and accessible to those who are looking for EdTech solutions worldwide.

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Rapid Evidence Reviews

This publication is one part of a series of Rapid Evidence Reviews (RERs) produced by EdTech Hub. The purpose of the RERs is to provide education decision-makers with accessible, evidence-based summaries of good practice in specific areas of EdTech. The reviews initially focused on topics that were particularly relevant in the context of widespread global challenges to formal schooling as a result of the Covid-19 pandemic, but now extend to cover further areas. All the RERs are available at https://edtechhub.org/research/.

Contents

Abbreviations and acronyms

BLCCRBP	Beneficiary-Led Climate Change Resilience Building Programme
EdTech	Educational technology
EiE	Education in emergencies
EMIS	Educational Management Information System
FCDO	Foreign, Commonwealth and Development Office (UK)
GIS	Geographical Information System
ICT	Information and communication technology
LMIC	Low- and middle-income country
NGO	Non-governmental organisation
STEM	Science, Technology, Engineering, and Mathematics
TPD	Teacher professional development

Executive summary

This rapid evidence review (RER) provides a synthesis of recent evidence relating to the use of educational technology (EdTech) for building climate resilience within education systems in low- and middle-income countries (LMICs). The review aims to provide educational stakeholders with an overview of the key themes in existing literature regarding how technology can be used to improve the climate resilience of education in LMICs. Based on the thematic findings, this study considers the design considerations that can support the effective design and deployment of EdTech interventions in these contexts, potential barriers and challenges, and implications for research, policy, and practice.

This review includes literature generated between 2014 and 2025 on EdTech and climate resilience. Following a two-step screening process, 38 sources were identified for analysis. During the thematic analysis process, data was organised according to the following four themes that were taken from ↑Marin et al. (2024), whose report suggests that policymakers should act on these four themes in order to adapt education systems for greater climate resilience:

1. Education management for climate resilience
2. School infrastructure for climate resilience
3. Ensuring learning continuity in the face of climate shocks
4. Leveraging students and teachers as change agents.

The analysis presented in this RER focuses on the EdTech-specific aspects of these four themes, as summarised below.

Theme 1: Education management

The literature identifies several promising education management strategies that can utilise EdTech for building climate resilience, emphasising three areas in particular:

- The use of multidisciplinary, cross-sectoral, and systems thinking approaches, which can be enhanced through the use of digital tools that promote collaboration and collective action.
- The strategic use of robust and real-time data to inform decision-making at national, sub-national, and school levels.

- Ensuring that EdTech is integrated into governance systems and policy to support the management of related educational processes.

Theme 2: School infrastructure

The literature presents several areas where EdTech can support school infrastructure in preparation for and in response to climate shocks. These include the use of EdTech to integrate risk-informed practice into educational infrastructure design and disaster preparedness, being adaptive and making structural adjustments to infrastructure based on assessment data, and enabling cost-effectiveness through the use of robust data for decision-making and intervention evaluation.

Theme 3: Ensuring learning continuity

The literature emphasises the importance of maintaining educational continuity during climate-induced disruptions. This draws on evidence related to EdTech use and its successes and challenges during the Covid-19 pandemic and education in emergencies. This theme also considers the ways in which EdTech can support the prevention of learning loss in the face of climate shocks, as well as how it can be designed and deployed to address educational inequality.

Theme 4: Leveraging students and teachers as change agents

The literature widely indicates the importance of the role of students and teachers in building climate resilience. The documents included in this review largely focused on curriculum reform, teacher professional development, and community and parental awareness and involvement. The evidence indicates that the active involvement and leadership of students, teachers, and community members in climate change education can be a cost-effective strategy to build climate resilience and lead to a broader understanding of risks and more effective preparedness strategies. This is particularly important for vulnerable groups who are at higher risk of being affected by climate-related issues.

Design considerations

The findings offer a series of design considerations, which suggest EdTech interventions that focus on supporting climate resilience should:

- Foster collaboration with other sectors and stakeholders.

- Include stakeholder voices in the design and implementation of EdTech interventions.
- Utilise context-responsive design, as there is a need to tailor EdTech solutions to local climate risks and infrastructural challenges
- Leverage available technology.
- Provide quality, continued teacher training and support.
- Mitigate educational inequity through design principles that target populations such as girls, learners with disabilities, and learners in remote communities.
- Integrate EdTech design with climate-resilient design.
- Ensure that EdTech design includes the collection, analysis, and dissemination of data.
- Reconsider the conceptualisation of EdTech.

Barriers

Continued barriers include the following areas: context-related challenges regarding the need for locally grounded climate resilience content; varying engagement levels in EdTech interventions; the lack of school leadership, teacher and curriculum capacity; challenges regarding access to EdTech infrastructure, digital skills, and level of learning content; policy and governance gaps; and financial and resource constraints.

Implications for research, policy, and practice

The RER highlights implications for research, policy and practice, including the need for:

- Developing clearer definitions of related terminology, including infrastructure and resilience.
- Undertaking robust, empirical research that explores and evaluates the use of specific EdTech interventions to build climate resilience.
- Incorporating the large body of research adjacent to this field in future evidence and literature reviews.
- Carefully considering the methodological approaches that are most appropriate for undertaking research in this area.

- Promoting long-term, sustainable funding commitments and better cross-sector collaboration to support impactful interventions that have the time and resources to make changes.

1. Introduction

1.1 Background and objectives

At EdTech Hub, our goal is to ensure that educational technology (EdTech) contributes to improving learning outcomes for children worldwide, regardless of their location or circumstances. We work in partnership with national governments and the global education sector to sustainably integrate EdTech into education policy and practice. A critical pathway to achieve this is through building the evidence base around EdTech, including what works and under what conditions. As part of our work to build evidence and contribute to the field of EdTech research, we conduct rapid evidence reviews into key issues. These reviews search for, analyse, and synthesise relevant literature and evidence utilising a systematic and efficient approach.

This rapid evidence review examines the intersection of EdTech and climate change to better understand how EdTech can be utilised effectively to build climate resilience in preparation for and in response to climate shocks in low- and middle-income countries (LMICs). EdTech is defined for this review as any "technologies —including hardware, software, and digital content—that are either designed or appropriated for educational purposes" (↑Hennessey et al., 2021, p. 8).

It is well recognised that climate change and extreme weather events are increasingly threatening the learning, enrolment and future prospects of students. As identified by ↑Marin et al. (2024), "the education of 75 million children is estimated to have been disrupted by conflict and natural disasters. These are projected to increase in frequency and severity with climate change" (p. 7). This includes both direct impacts on schools from climatic events and indirect impacts where other areas affected by climate change begin to impact education (see Table 1 below).

Table 1. *A list of direct and indirect impacts of climate change as specified by* ↑Marin et al. (2024, p. 7).

	Direct impacts	Indirect impacts
Area impacted by climatic effects	Extreme heat Tropical cyclones Floods Landslides Wildfires Droughts	Air quality (e.g., smoke) Food security Health (e.g., vector-borne diseases) Conflict Migration and displacement Economic shocks
Impact on education	Learning environments not conducive to learning (e.g., extreme heat) Destruction and/or temporary closure of schools Impacted access to quality service delivery at the school	Reduced student readiness to learn due to health and nutrition shocks Diminished demand for schooling due to household coping mechanisms Disruption to education services due to displacement and conflict

With less access to education and a reduction in educational attainment, lower earnings and productivity are projected across generations since "lower education attainment perpetuates cycles of poverty and limits social mobility" (↑Marin et al., 2024, p. 15). The literature (e.g., ↑Proctor, 2023) widely indicates that this is particularly the case for LMICs, which are expected to encounter the more severe impacts of climate change, and within affected communities, meaning that the most vulnerable children will bear most of the effects.

Therefore, research is urgently needed to identify the actions that can be implemented now to increase the capacity of education systems to adapt and cope with climate stressors, particularly in LMICs. In their report, ↑Marin et al. (2024) suggest four areas for policymakers to act on in order to adapt education systems for greater climate resilience:

1. **Education management for climate resilience** refers to how collaborative and polycentric governance approaches to education management, appropriate planning, and the strategic use of data can help build climate resilience at both system and school levels.
2. **School infrastructure for climate resilience** refers to how school buildings can be adapted to more appropriately deal with local climate impacts in a risk-informed and cost-effective manner.
3. **Ensuring learning continuity in the face of climate shocks** refers to how learning losses can be mitigated and equity ensured in the provision of remote learning during exposure to climate emergency contexts.
4. **Leveraging students and teachers as change agents** refers to how curriculum, pedagogy, teacher professional development, and local knowledge sharing can be adapted to better equip schools and communities with the knowledge to implement appropriate mitigation strategies to climate shocks.

This rapid evidence review uses these four areas as a thematic framework to analyse the key messages present in existing literature regarding how EdTech can be used to enable climate resilience in LMICs. The study provides a synthesis of existing data on the effectiveness of EdTech in building climate resilience within and across these four areas, highlighting examples of programmes, platforms, and devices. In doing so, it identifies recommendations for how further research might be most appropriately targeted to support the building of climate-resilient education systems in LMICs.

1.2 Central research question

This review is guided by the following research question:

> *What are the key themes present in existing literature with respect to how technology can be used to improve the climate resilience of education in LMICs?*

1.3 Structure of the report

Following this introduction, Section 2 offers details of the methodology, including the search and screening strategy, the inclusion criteria, and methodological limitations. Findings are then presented in Section 3 under the four main themes that guided this study. The report concludes with Section 4, which presents a synthesis of key learnings from the evidence regarding implementation strengths and barriers as well as implications for research, policy, and practice.

2. Methodology

This study uses a methodological approach informed by the Cochrane Collaboration Rapid Reviews Methods Group guidance on producing rapid reviews (↑Garritty et al., 2021). This approach enables a rigorous and systematic process while defining the scope narrowly enough so that it can be completed within a short timeframe.

2.1 Search and screening process

The study follows the standardised EdTech Hub rapid evidence review (RER) methodology, which includes a systematic sequence of searching (Step 1), screening (Step 2), and analysing (Step 3) relevant documentation. Because the study has four pre-determined themes, the methodological process outlined below was repeated for each theme.

Step 1: Title and abstract screening

A set of search strings was developed for each theme to search for relevant literature (see Annex). Searches were made on Google Scholar and the main Google search engine to capture a range of literature.

Results were screened based on the title and abstract or introduction, according to the following inclusion criteria:

- Sources must relate to the use of technology/EdTech.
- Sources must relate to the use of technology in building climate resilience of some form (which can include mitigating actions), with respect to any aspect of education delivery (e.g., systems, people).
- Sources must relate to primary or secondary-level education (including both formal and non-formal options).
- Sources must have been published between 2014 and 2025.
- Sources can come from academic or grey literature, but must have been published or endorsed by a recognised academic, governmental, or non-governmental organisation (NGO).
- Sources must provide details on the effectiveness of technology in building climate resilience.
- Sources must be situated in relevant countries classified as low- or lower-middle-income by the World Bank.

Sources that met the criteria were entered into a Google Sheet, which included a record of the search string used to find each source, the type of source, and the date the source was found. During this step, the research team found the criteria to be too restrictive, and allowances were made to include sources for analysis that offered valuable insights, but did not include effectiveness or readiness data regarding EdTech.

Additionally, the research team found a lack of available literature solely focused on LMICs. As a result, the inclusion criteria were expanded to consider sources that referenced LMICs or contained arguments, frameworks, or evidence applicable to LMICs, even if the source had a broader geographical focus. Furthermore, search strings were adjusted for both Google Scholar and Google Main as highlighted in the Annex because they were not returning enough relevant results.

The first 20 pages (200 results) or as many pages as returned by Google Scholar until the search string returned two consecutive pages of no relevant results were screened. Details regarding this process (i.e., the number of pages screened, total number of results, number of sources screened) were recorded for internal record-keeping and to build institutional methodological memory. Sources found through snowball sampling were also included in the Google sheet.

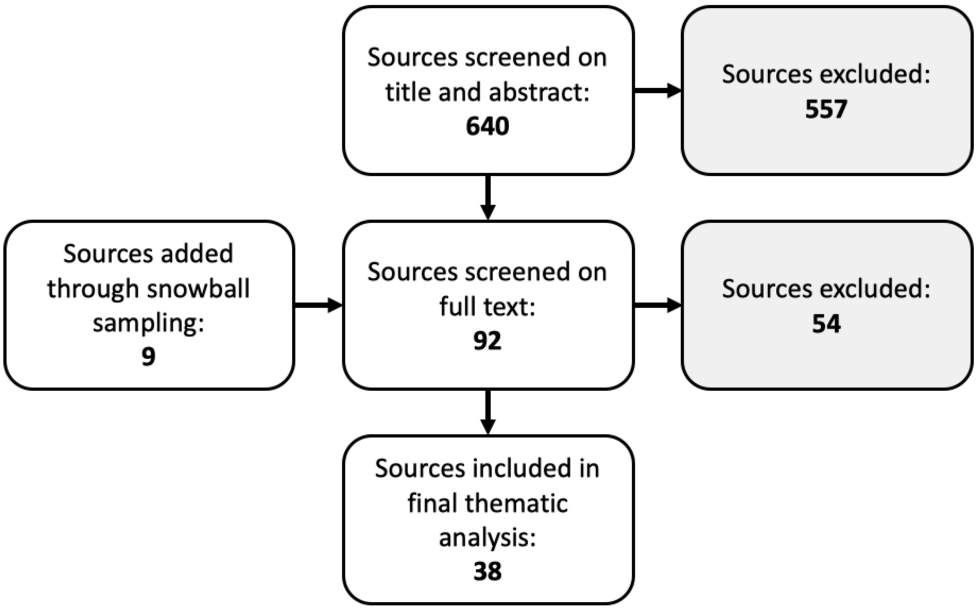
Step 2: Full-text screening

During Step 2, the 86 texts that met the inclusion criteria were read in full to assess content and quality. The research team evaluated the rigour of the methodology adopted, accuracy of spelling and grammar, and reputability of the authoring or publishing organisation. If the texts met the quality criteria in these areas, they were marked for inclusion in Stage 3.

Step 3: Thematic analysis

All 38 documents that passed the full-text screening were analysed thematically. This involved systematically reviewing each document according to an analytical framework that was input into Google Sheets. This framework was developed in response to the research question and informed by patterns noted during the screening process. Framework components included notes regarding topic areas, geographical focus, aspects of climate discussed, impacts of climate on education discussed or vice versa, type of EdTech discussed and its objectives and associated evidence and data, and barriers to the use of EdTech for building climate resilience. The search and screening results are presented in Figure 1 below.

Figure 1. *Search and screening results*



2.2 Limitations

This study encountered a range of limitations related to evidence, process, and methodology.

The most significant limitation was the lack of robust evidence available for inclusion. In particular, very few documents contained effectiveness data regarding specific interventions, which demonstrates the need for empirical data and high-quality studies on EdTech and climate resilience. The literature included in this review was largely theoretical or drew on evidence from the Covid-19 pandemic or education in emergencies. As a result, some of the content is related to EdTech indirectly and some of the analysis is more exploratory in nature. This is appropriate within the context of a review that addresses such a nascent and niche technical topic. It is clear that a significant gap remains in the evidence base regarding implementation data for the use of EdTech to build climate resilience.

Process-related limitations include utilising the four themes as an overarching framework of the research and having a highly structured analytical framework prior to document gathering and analysis. This was an appropriate decision, designed to reflect the research conducted by ↑Marin et al. (2024) and to create a more efficient analysis process. However, due to the limited available evidence and the significant overlap in themes, this created a challenging process that required repeated analysis of sources that were relevant to more than one theme.

Inclusion criteria were likely too strict at the outset of the study. This level of specificity would have been helpful if there were a larger body of evidence to draw on for this review. However, due to the relative scarcity of relevant documents, the inclusion criteria had to be adjusted and re-adjusted continuously throughout the review. This created inefficiencies in the process and likely meant that documents that did not meet the inclusion criteria but which may still have offered relevant insights were missed.

3. Findings

This section begins with an overview of the screened and included literature to provide context about the evidence base. Findings are then presented and discussed within the framework of the four overarching research themes cited in ↑Marin et al. (2024):

1. **Education management for climate resilience**
2. **School infrastructure for climate resilience**
3. **Ensuring learning continuity in the face of climate shocks**
4. **Leveraging students and teachers as change agents.**

The findings explore the key messages in the literature for each of these themes. Where available, intervention spotlights have been included in relevant sections to exemplify the findings.

3.1 Overview of the analysed sample

This review included varied literature that sat within or across the four themes:

- **Type of source:** 16 were reports, 16 were journal articles, 3 were online articles / blogs, 2 were book chapters, and one was a thesis.
- **Focus context:** 17 of the sources had a broad geographical focus with no identified focal context, but nonetheless contained findings pertaining to LMICs. Ten sources focused on multiple countries, which were organised according to national economic output (3 sources focused specifically on LMICs) or specific regions, with the most common focus region being sub-Saharan Africa (3 sources). Of the 11 sources that had a specific focus on one country, the most frequent focus countries were Indonesia (2 sources), Pakistan (2 sources) and the Philippines (2 sources).
- **Methodology:** 10 of the sources documented evidence from primary data collection, although rigorous effectiveness testing was limited, with only 4 using quasi-experimental designs or primary modelling data. The other 6 relied on qualitative reflections from the primary research. As mentioned above, due to the lack of sources which included primary data on effectiveness, the criteria were expanded to include relevant secondary sources. Twenty-seven of the sources provided a feasibility or effectiveness assessment of the use of

EdTech for climate resilience based on secondary data. This included assessments of existing literature, case studies, policies, and stakeholder opinions. An additional policy document source was also included.

3.2 Theme 1: Education management

Education management plays a critical role in building climate resilience by supporting adaptation and disaster risk planning at both the sector and school levels (↑Marin et al., 2024). The literature suggests several promising education management strategies for building climate resilience, emphasising three areas in particular: **multidisciplinary, cross-sectoral and systems thinking** (Theme 1A), **the strategic use of data** (Theme 1B), and **governance systems and policy** (Theme 1C).

Theme 1A: Multidisciplinary, cross-sectoral and systems thinking

There is a clear, documented need for a non-linear approach to education management that recognises the complexity and challenges presented by climate change. Multidisciplinary, cross-collaborative, and systems-thinking approaches can offer a way to account for this complexity in educational settings, focusing on the interactions between different components of a system, as well as between systems, in order to support climate resilience. This approach recognises and seeks to address the wide range of direct and indirect impacts (see Table 1 above) of climate change on education (↑Fitzpatrick & Amenya, 2023; ↑Hernández, 2015; ↑Prazian & Prykhodko, 2023; ↑Seddighi et al., 2020; ↑Teixeira & Crawford, 2022).

A systems-thinking approach to education management can support stakeholders in comprehending and conceptualising climate education and resilience more deeply (↑Ignacio et al., 2023; ↑Teixeira & Crawford, 2022). This can equip educational decision-makers with the ability to prioritise issues effectively, whether that is focusing on climate change in relatively stable times or on sustainability during crises and climate shocks (↑Chirambo, 2018).

↑Fitzpatrick & Amenya (2023) propose that to adequately respond to the complexities of climate change, adaptive actions taken in education should also include multidisciplinary and cross-sectoral efforts. For example, ensuring that the education sector works closely with other sectors such as health, infrastructure, agriculture, and social security government departments can strengthen the education sector's response to climate change. This multidisciplinary approach can also help reframe climate change from an environmental problem to, for example, a security or economic issue or an opportunity to eradicate poverty and promote equality (↑Chirambo, 2018).

A role for EdTech within this area is to ensure that education management processes and education management information systems (EMISs) holistically engage educational stakeholders in building climate literacy (↑Ignacio et al., 2023; ↑Mazari et al., 2022). Due to the flexibility offered by EdTech interventions, ↑Chirambo (2018) argues that educational stakeholders are uniquely positioned to provide mechanisms that promote the integration of climate change education into other sectors and subject areas, enabling stakeholders to develop new practices and strategies for managing climate change risks. This could, for example, leverage educational platforms and digital tools to promote collaboration and collective action among different areas of governance as well as between government and non-state actors (↑United Nations, 2024).

Theme 1B: Strategic use of data for risk reduction

Within education management, planning and decision-making at all levels should be underpinned by clear data and analysis related to climate risks and possible mitigation strategies. Effective preparation for, and recovery from, climate shocks requires education decision-makers to fully understand the climate risks faced by their sector and individual communities. Similarly, there also needs to be an easy way to assemble and discuss data to stay informed, should there be any changes to current good practice.

EdTech can help ensure that decision-makers are provided with the right data at the right time so they can prioritise interventions that benefit vulnerable populations (↑Heeks & Ospina, 2013 ↑Momoh & Atherton, 2022; ↑United Nations, 2024). For example, the Department of Education in the Philippines, in partnership with Save the Children and the Prudence Foundation, launched a set of digital tools to inform planning and decision-making at the national, sub-national, and school levels (↑EiE Hub, 2023). These tools and data can help reduce exposure to climate-related disruptions for key parts of the educational system before climatic events take place.

The strategic use of localised data can also be integrated into early warning systems to alert schools and communities in real time and enable early action to minimise damage (↑Cui et al., 2024; ↑Sabarwal et al., 2024; ↑United

Nations, 2024). For example, ↑Fitzpatrick et al. (2024) and ↑GSMA (2022) highlight the role that mobile phone technology can play in facilitating the provision of real-time data and information. This information is crucial for preparedness and can also help stakeholders understand the extent of any damage resulting from climate shocks (↑United Nations, 2024). Additionally, mobile phones can provide an avenue for communication regarding socio-emotional support and updates on school disruption and return dates (↑Mazari et al., 2022). However, it is essential that data-led responses are well-coordinated at the administrative level, as fragmented responses can lead to the deployment of multiple conflicting solutions with inefficient data sharing and coordination between key stakeholders (↑GSMA, 2022).

Theme 1C: Governance systems and policy

Research indicates that climate literacy in schools is often constrained by a lack of innovative governance systems and comprehensive policies that can support the delivery of climate educational content to prioritise preparedness and climate resilience (e.g., ↑Chirambo, 2018; ↑Prazian & Prykhodko, 2023; ↑Sabarwal et al., 2024; ↑Seddighi et al., 2020; ↑Tauson & Stannard, 2018; ↑United Nations, 2024). This includes incorporating the realities of climate change into national and subnational policies that articulate the impact of climate change on education, as well as the role education should play in addressing climate change.

↑Seddighi et al. (2020) also emphasise the importance of more granular, local, and community-oriented policies that involve all community members in disaster preparedness as an education management strategy to ensure families and caregivers are equipped to support continued learning in the face of climate shocks. ↑Heeks & Ospina (2013) note that this is an important step for the self-organisation of low-income and vulnerable communities in particular, so that they are equipped with the independent capacity to make decisions and take actions that promote effective and localised preparedness and response to climate hazards.

This approach should also extend to school-level management, which recognises the importance of and potential for climate change resilience to be built within the classroom and school. Support for schools and communities should be provided to contextualise materials and build capacity, for example, through the use of digital tools like Geographical Information Systems (GIS), which can be used to support communities to make data-driven decisions. This approach and associated policy should also explicitly address equity barriers (see Theme 3C).

Adjustments to governance systems and policy would benefit from adherence to the previous sub-themes regarding multi-sector coordination and financing, as well as robust risk reduction data. The literature promotes a polycentric approach whereby partnerships and collaboration take place between:

- government departments to mainstream climate change communication across formal educational contexts (↑United Nations, 2024);
- governments and development partners to ensure investments in educational response are scalable (↑Mazari et al., 2022);
- governance systems and the private sector to improve access to information and communication technology (ICT) educational platforms that can support climate change education (↑Chirambo, 2018).

This collaboration can result in co-constructed knowledge between entities and institutions, ultimately supporting skill acquisition (↑UNESCO, 2015). Promising examples include:

- The Technologies and Practices for Small Agricultural Producers (TECA) platform[1] which offers opportunities for exchanging technologies and practices on climate change and disaster risk reduction (↑UNICEF, 2023).
- The Science Learning Network has demonstrated strong potential for fostering collaborations between governmental and scientific institutions (↑UNICEF, 2023).
- The Beneficiary-Led Climate Change Resilience Building Programme (BLCCRBP) in Malawi demonstrates how polycentric governance approaches may be used to facilitate climate change and entrepreneurship education in secondary schools (↑Chirambo, 2018).

Robust data is also necessary for climate-smart education systems to effectively utilise EdTech in building climate resilience and reducing their own climate footprint. This could include the use of technology and digital systems to support the management of educational processes through the automation of key management processes and the use of EMISs, such

[1] See https://teca.apps.fao.org/en/categories/Climate-Change-Adaptation-and-Disaster-Risk-Reduction. Retrieved 10 June 2025.

as student and teacher registrations, and school censuses (↑Bos & Schwartz, 2023).

3.3 Theme 2: School infrastructure

The literature identifies several critical areas that are essential for understanding how EdTech can support resilient school infrastructure in preparation for and in response to climate shocks. These include the use of EdTech to facilitate **risk-informed practice** (Theme 2A), **being adaptive and making structural adjustments** (Theme 2B), and **enabling cost-effectiveness** (Theme 2C).

Theme 2A: Risk-informed practice for school infrastructure

As an extension of Theme 1B, EdTech can be used to better understand climate-related risks and incorporate these into educational policy and practice, both for current school infrastructure and new builds. This can aid in safe school construction practices as well as adapting and retrofitting schools to make them more resilient to climate change and shocks (↑Luetz, 2020; ↑Nassirpour et al., 2018).

The literature recommends that policy frameworks for risk reduction include the development of local and national policies that integrate risk-informed practices into educational infrastructure design and disaster preparedness (see, for example, ↑EiE Hub, 2023; ↑Khan, 2022; ↑Luetz, 2020; ↑Nassirpour et al., 2018). This should include a multi-hazard risk preparedness approach to develop resilient educational infrastructure and dynamic risk assessment tools that can leverage available technologies.

↑Nassirpour et al. (2018) recommend developing a comprehensive dataset that includes information regarding structural characteristics, common defects, and typical damage associated with climate shocks. Examples include digital tools for climate data collection, such as geospatial tools like GIS, which is used for real-time risk assessment, vulnerability mapping of school infrastructure, and adaptive management (↑Khan, 2022). Similarly, the Ministry of Education in Sierra Leone is working with education advisors Fab Inc. to develop a web-based data tool that helps estimate and prioritise where new schools are really needed or where renovations or additional classrooms are most appropriate, given the locations' climate risk and contextual socio-economic factors (↑Momoh & Atherton, 2022).

This approach to risk-informed practice can equip stakeholders, including educators and school administrators, with knowledge of climate risks and adaptive strategies for infrastructure. This can enable effective decision-making and support the strategic allocation of resources to retrofit specific school structures. For example, new classrooms could leverage research data and digital tools to be designed to stay cool, such as through the use of natural ventilation, insulating materials, and climate-responsive designs. Digital tools can also create more pathways for the dissemination of information, for example, to ensure that local building codes are understood and complied with.

↑Opabola et al. (2023) note, however, that time and financial constraints often create barriers to carrying out school preparedness drills. Government monitoring of preparedness exercises through the use of digital tools could significantly mitigate this challenge. In addition, ↑Nassirpour et al. (2018) call for a conceptual shift in education and climate change from 'emergency response' to 'preparedness', with risk-informed planning being a key tool for delivering preventative measures.

Theme 2B: Adaptation and structural adjustments

The literature makes it clear that demolishing existing buildings and constructing new eco-friendly structures is not a cost-effective practice for mitigating climate change. Rather, current buildings can be retrofitted with climate-friendly (and budget-friendly) components that can protect the infrastructure and ensure that the learning environment promotes student learning and wellbeing.

A growing body of knowledge exists regarding the design of resilient school infrastructure that aligns with sustainability principles (e.g., ↑Nassirpour et al., 2018; ↑Opabola et al., 2023). Bioclimatic architecture is one approach that aims to create comfortable learning environments using local resources, which can be crucial in mitigating the impacts of climate change. Specific opportunities for EdTech in these scenarios include incorporating climate risk assessments into school infrastructure adaptation planning, as well as serving as a tool for conducting vulnerability assessments and mapping to identify the most efficient ways to improve infrastructure resilience. EdTech tools can also be effective for data collection, monitoring, and response during climate-related crises, allowing for the assessment of infrastructure and the derivation of required adaptations for greater resilience.

Further recommendations from the literature include incorporating green and blue infrastructure, using natural elements such as trees, gardens, and water-sensitive systems to mitigate the impact of extreme weather events on school buildings (↑Bangay, 2024; ↑Cui et al., 2024; ↑Sabarwal et al., 2024).

Understanding the potential impact of natural elements surrounding school infrastructure on mitigating climate hazards should feed into decision-making regarding which adaptation and retrofit options are most sensible and cost-effective. The literature also recommends ensuring energy and resource efficiency by incorporating sustainable practices, such as switching to renewable energy sources and implementing water conservation technologies in school infrastructure (↑Bangay, 2024; ↑Cui et al., 2024; ↑Proctor, 2022; ↑Sabarwal et al., 2024). Appropriate water conservation is especially critical in ensuring the impact of climate-resilient retrofits can be maximised, as their impact on learning will likely be minimal without an appropriate supply of water to keep students and staff hydrated. Technology can play a crucial role in helping map areas most vulnerable to water shortages so that appropriate water supply measures can be implemented, which can help provide the foundational support needed for retrofit interventions (such as those addressing extreme heat) to be impactful (↑Bangay, 2024).

Theme 2C: Cost-effectiveness considerations

Most of the papers included in this review discuss the financial aspect of investing in climate-resilient infrastructure, which positions climate change education within macroeconomic considerations. While even simple adaptations to school infrastructure can be expensive, particularly for already marginalised communities in LMICs, post-disaster recovery can be much more expensive. Poorly planned infrastructure can leave systems and communities more vulnerable to disruption and exacerbate longer-term social and economic costs (↑Luetz, 2020; ↑Opabola et al., 2023; ↑Tauson & Stannard, 2018).

This case for cost-effectiveness needs to be clearly made for investing in disaster risk reduction to make education systems more climate resilient. EdTech can provide platforms and engaging resources for mobilising this case to increase buy-in. This should draw on research indicating that climate-resilient schools are a sustainable and long-term investment in community stability, economic recovery, and educational outcomes (↑Luetz, 2020; ↑Opabola et al., 2023; ↑Sabarwal et al., 2024).

EdTech does not always represent the best value for money for enhancing learning outcomes, and consequently, there is a need for continuous cost-effectiveness analysis to evaluate the efficacy of interventions (↑Proctor, 2022; ↑Tauson & Stannard, 2018). Where evidence does not exist, predictive modelling can be used to support cost-effectiveness analysis for robust estimations (e.g., as was conducted in ↑Proctor, 2022).

3.4 Theme 3: Ensuring learning continuity

The literature emphasises the importance of maintaining educational continuity during climate-induced disruptions. This draws on evidence related to EdTech use during the **Covid-19 pandemic and education in emergencies** (Theme 3A) as well as how EdTech can support **the prevention of learning loss** (Theme 3B) and **address educational inequality** (Theme 3C).

Theme 3A: Lessons learnt from the Covid-19 pandemic and education in emergencies

The literature regarding using EdTech to ensure learning continuity in the face of climate shocks draws significantly on lessons learnt from the Covid-19 pandemic and education in emergencies (EiE). School closures in these contexts provide evidence for the sector to recognise and reflect on what worked and what challenges existed that could be mitigated in future interventions. Relevant lessons learnt from these contexts for the intersection of climate change education and EdTech are summarised in the bullet points below. Evidence from Covid-19-related studies suggests a measure of validation for this approach, as the lessons from EiE literature echo many of the sub-themes identified in this review. These insights draw on the following publications: ↑Bos & Schwartz (2023); ↑Cameron et al. (2024); ↑Crompton et al. (2021); ↑Fitzpatrick et al. (2024); ↑Hallgarten et al. (2020); ↑INEE (2023); ↑Mazari et al. (2022); ↑Opabola et al. (2023); ↑Tauson & Stannard (2018); ↑UNESCO (2023).

- Multi-sector collaborations among governments, learning institutions, NGOs and the private sector are necessary for effective emergency response and optimal EdTech design and implementation.
- EdTech requires strategic integration with policies and curricula, since it is a tool and not a universal solution. How EdTech is used and for what purpose can vary significantly between operating contexts.
- It is crucial to minimise the length of school disruptions and to provide remedial learning programmes when learners return to school, since learning losses will not be the same for all students.
- Socio-emotional and psychosocial support should be included in educational programmes to address the psychological impact of climate shocks and students' associated anxiety and distress.

- Inclusivity and access should be central in the design and implementation of EdTech. The use of EdTech supported learning continuity for many students during the Covid-19 pandemic. However, many students did not benefit from EdTech and inequities in access to technology were exacerbated.
- Educational authorities need to communicate decisions and measures to schools, teachers, students, parents, and the wider community.
- It is vital to conceptualise EdTech interventions and remote learning as likely to be temporary and consider whether and how they can be integrated into the school system once students return. This ensures that the EdTech intervention does not replace in-person studies and remains adaptable.
- Experimentation and innovation should be supported to rigorously assess what EdTech interventions are feasible in different emergency contexts. This will help ensure that interventions are evidence-driven and more able to respond appropriately to the contextual needs of teachers, students, parents, and the wider community.

Barriers to accessing EdTech interventions during the Covid-19 pandemic and EiE included physical barriers such as infrastructure (↑Hallgarten et al., 2020; ↑Ignacio et al., 2023), a lack of digital skills (↑Ignacio et al., 2023), a lack of capacity to teach through online modalities and assess the quality of learning remotely (↑Ignacio et al., 2023), as well as barriers associated with physical and mental health that are typically aggravated by disasters (↑Ignacio et al., 2023; ↑Selwyn, 2021). The literature on the Covid-19 pandemic and EiE also demonstrates that during times of crisis, marginalised groups, including girls and women, people with disabilities, and those in rural communities, among others, suffer disproportionate harm. Yet, these groups are often invisible in disaster risk reduction planning (↑Cameron et al., 2024).

The literature on EiE and the Covid-19 pandemic importantly highlights that we need to ask more probing and critical questions about the use of EdTech during disasters such as climate shocks. ↑Selwyn (2021) argues that the pandemic provides evidence of the limitations of the ways in which EdTech has been conceptualised and the future that has been anticipated within EdTech. The pandemic provided the education sector with a reminder that futures can be uncertain and vulnerable. This lens can prompt the sector to radically rethink how to engage most effectively with EdTech. In order to anticipate risks, it can be useful to undertake a process of imagining future catastrophes and use these conjectures as a basis for engaging in collective action to help prevent them (↑Selwyn, 2021).

Theme 3B: Mitigating learning loss

Climate shocks, such as droughts, flooding, and extreme temperatures, significantly disrupt schooling and therefore learning. The literature on education in emergencies, particularly in refugee and displaced settings, presents a compelling argument regarding how digital tools and platforms can facilitate remote learning during crises, ensuring continuity of education (e.g., ↑INEE, 2023; ↑Sabarwal et al., 2024; ↑Tauson & Stannard, 2018). To mitigate learning losses, EdTech interventions can be designed to provide remote learning during periods of school closures (↑Bos & Schwartz, 2023; ↑Fitzpatrick & Amenya, 2023), in order to fill in gaps during disruption and increase the speed with which learners can return to their studies (↑Tauson & Stannard, 2018). These interventions should play a supporting role in delivering education, rather than acting in place of teaching (↑Tauson & Stannard, 2018), as also mentioned in Theme 3A above.

A level of coordination is required for these interventions to be designed appropriately, which should include dialogue with ministries, school staff, teachers, parents, and community members to understand what is needed during disruptions. EdTech needs to be responsive to learners' levels and needs, as well as adaptable to differing pre-existing skills and experiences (↑Tauson & Stannard, 2018). This draws on ↑Vygotsky et al.'s (1978) theory of the zone of proximal development, which suggests that scaffolding is necessary to enable learners to interpret new information in a logical and progressive way.

These interventions should be initiated in line with early warning systems and may include the use of mobile phones and digital learning platforms to deliver education to displaced learners in regions affected by climate-related disasters (↑Fitzpatrick & Amenya, 2023). They should also be mediated by a teacher or caregiver (↑Tauson & Stannard, 2018; see Themes 4B and 4C).

They will likely require (and should plan for) technological infrastructure, including devices, online platforms and content, as well as human resources and a system of governance (↑Bos & Schwartz, 2023). Importantly, all interventions should be considered in advance as part of risk planning and evaluated for accessibility, as well as broader barriers such as psychological factors and physical needs, such as hunger and access to water. As mentioned above in Theme 3A, when schools are closed due to climate shocks, remedial learning programmes are needed to mitigate learning loss (↑Fitzpatrick & Amenya, 2023).

Theme 3C: Addressing educational inequality

Children are particularly vulnerable to the impacts of climate-related disasters and are more likely to suffer from injuries, malnutrition, and mental health issues during and after disasters (↑Fitzpatrick et al., 2024; ↑Marin et al., 2024). This necessitates targeted protective measures. The adverse effects of climate shocks are particularly damaging to children from poorer households and other vulnerable groups, such as girls, exacerbating existing inequalities (↑Alò et al., 2020; ↑United Nations, 2024).

The literature asserts that climate change will disproportionately affect marginalised learners because of the intersection of climate shocks and pre-existing inequality (most documents included in the review note this to some extent, with particular synthesis provided by ↑FCDO, 2022; ↑Fitzpatrick & Amenya, 2023; ↑Marin et al., 2024; ↑UNICEF, 2023). Girls and young women in particular will be more affected by climate change impacts, exacerbating current educational inequality. This is due to systemic issues regarding barriers to accessing education that reemerge during disasters (↑UNICEF, 2023).

EdTech used to ensure learning continuity in preparation for and in the face of climate shocks can usefully employ a conceptual framework that acknowledges this inequity in order to make strides in addressing it (↑Teixeira & Crawford, 2022). This may include training for innovations ahead of a climate shock that incorporates girls' perspectives and experiences, and ensuring that they are confident in using the technology. This may also include ensuring that community members and caregivers are aware of the importance of learning continuity for all children through targeted awareness-raising activities and educational materials.

Examples include the Greentech Skills for Girls programme in Kazakhstan, Kyrgyzstan, and Uzbekistan, which supports the development of a satellite learning platform to enable girls to better understand and interact with satellite technologies, through collecting data on environmental issues such as air pollution (↑UNICEF, 2023). ↑Fitzpatrick & Amenya (2023) also recommend building the capacity of the private sector to promote gender-responsive climate technologies and innovations.

3.5 Theme 4: Leveraging students and teachers as change agents

The literature widely indicates the importance of the role of students and teachers in building climate resilience. Included documents largely focused on: **curriculum and pedagogical reform** (Theme 4A), **teacher professional development** (Theme 4B), and **community and parental awareness and involvement** (Theme 4C). Theme 4A: Curriculum and pedagogical reform

Education plays a crucial role in ensuring students understand climate risks and are prepared for climate shocks. However, evidence suggests that students do not have the knowledge, values, or capacity to take action (↑Bos & Schwartz, 2023; ↑Chirambo, 2018; ↑Marin et al., 2024; ↑United Nations, 2024). Curriculum and pedagogical approaches need to be adapted to provide students with the contextual knowledge and values needed to take action, and need to maintain flexibility to account for environmental changes and new knowledge that is generated (↑Alò et al., 2020; ↑Fitzpatrick & Amenya, 2023; ↑Prazian & Prykhodko, 2023; ↑Tauson & Stannard, 2018; ↑Teixeira & Crawford, 2022; ↑United Nations, 2024).

ICT modalities can provide the means to access materials and support related to climate change education, particularly in schools that lack a curriculum or trained teachers (↑Chirambo, 2018). However, the literature cautions that without integration into curricula, the content will have less engagement, relevance, or sustained impact (e.g., see ↑Hernández, 2015; ↑Prazian & Prykhodko, 2023; ↑Sabarwal et al., 2024; ↑Tauson & Stannard, 2018). This was supported by a significant number of documents included in the review, which recommend that climate education is integrated with foundational learning or other subjects that promote systems thinking, innovation, and agency.

For example, climate lessons can be woven into literacy and numeracy instruction for the younger years, allowing students to learn about climate issues without compromising essential skills. This approach can include practical examples, such as calculating sea level rise in maths exercises. The role of EdTech in this context includes using innovative disaster education methods that are interdisciplinary, interactive, and engaging, such as those incorporating play, art, and storytelling (↑Fitzpatrick et al., 2024). ↑Alò et al. (2020) also note that this does not need to be resource-intensive, and low-cost alternatives often provide more realistic routes for sustainable scaling.

For older students, climate education can be integrated into entrepreneurship to enhance their agency in enacting problem-solving strategies (↑Chirambo, 2018; ↑Sabarwal et al., 2024). Further EdTech models to draw on could include virtual reality, time graphs that depict patterns of change over time, or simulators to engage learners and offer a clearer understanding of climate shocks and to evaluate the impact of policy decisions on greenhouse gas emissions (↑Ignacio et al., 2023; ↑Seddighi et al., 2020). Science, Technology, Engineering, and Mathematics (STEM) education also provides an encouraging means to support climate resilience by equipping learners to improve data collection and analysis, and fostering innovation and technological awareness (↑United Nations, 2024).

Importantly, content should be created specifically for the setting, which involves assessing pre-primary, primary, and secondary curricula to determine how climate topics can be effectively integrated into various subjects (↑Ignacio et al., 2023; ↑Sabarwal et al., 2024). ↑Tauson & Stannard (2018) similarly highlight that content and examples included in EdTech interventions need to be relevant to the learners' context in order to support engagement. This is also supported by the ↑United Nations (2024), which emphasises the importance of promoting community-specific climate change literacy through education that focuses on adaptation measures and skills development, such as through the use of community-based role models actively engaged in climate action. This local focus can address what ↑Chirambo (2018) cautions, namely that the impact of abstract or non-contextualised climate education can be limited, as climate resilience is often not perceived as impactful at an individual level. If learners do not think actions can have an impact, they will have little motivation to engage with or advocate for them.

Those involved in designing curricula and any associated EdTech interventions must also carefully consider the pedagogical model and conceptual framework for the delivery of climate change education. The literature identifies three key areas to draw on when considering pedagogy: learner agency and empowerment, support for cognition, and lifelong learning. Learner agency and empowerment refers to recognising that learners (whether that is the student, teacher, or community member) are not passive recipients of education but can be advocates for climate change mitigation and disaster preparedness within their families and communities (↑Marin et al., 2024; ↑Seddighi et al., 2020; ↑United Nations, 2024). For learners to become change agents and champions of climate resilience, they not only require content knowledge but also need to be empowered to act on it.

In addition to learner agency, pedagogical models should support experiential learning and cognition (↑Alò et al., 2020; ↑García et al., 2018; ↑Teixeira & Crawford, 2022; ↑United Nations, 2024). This is in contrast to rote learning or presenting content, which typically does not require active engagement by learners. This reiterates the point that it is not the EdTech intervention that matters, but rather the pedagogy and wider educational activities that promote collaboration and enhance learning outcomes. Problem-based and inquiry learning are often linked with constructivist approaches to education (e.g., ↑Vygotsky et al., 1978), which can leverage technology to facilitate deeper engagement and understanding of climate-related issues and emphasise learner autonomy and agency (↑Teixeira & Crawford, 2022). EdTech software should enable this and encourage active, engaged learning, which aligns with learners' skill levels and contexts (↑García et al., 2018; ↑Tauson & Stannard, 2018).

Lifelong learning is also an important conceptual framework for climate change education, enabling individuals to keep pace with changes in climate, jobs, and technologies (↑Bos & Schwartz, 2023). This supports learners in continuing their learning beyond the classroom and can prepare them for changing markets and societal needs (↑Prazian & Prykhodko, 2023).

Theme 4B: Teacher professional development

Teachers play a critical role in shaping students' values and critical thinking abilities, which are essential for them to become agentive, engaged, climate-resilient citizens. Teachers can also ensure that students are aware of climate risks affecting their region, how to act in the event of one materialising, as well as the role students themselves could play in risk management. The quality and delivery of climate education in schools are therefore dependent on teachers having access to associated knowledge and training (↑Hernández, 2015; ↑Ignacio et al., 2023; ↑Sabarwal et al., 2024; ↑Tauson & Stannard, 2018; ↑Teixeira & Crawford, 2022; ↑United Nations, 2024).

EdTech interacts with this theme in two ways: first, as a method by which teachers can access professional learning content and communities on teaching climate change education (e.g., through online professional learning programmes and networks); second, as the model that teachers need to be trained to use (i.e., in case of remote learning, teachers need to be trained on how to use EdTech effectively).

There is a clear opportunity for EdTech to provide teacher professional development (TPD) using technology-informed learning (↑Proctor, 2023). Online or blended professional learning programmes can provide participants with more flexibility, agency, and opportunities for peer exchanges with others, as well as opportunities for ad hoc support and the provision of resources following climate shocks. ↑Teixeira & Crawford (2022) note that technology does not need to be high-cost to create online communities; for example, using WhatsApp groups for teacher-to-teacher exchange.

Training teachers on how to use EdTech to build climate resilience or in the face of climate shocks requires careful consideration of the context and teachers' perceptions of EdTech (↑Sidze, 2016). In their review of evidence, ↑Tauson & Stannard (2018) highlight the need for teacher training on the use of EdTech to be extended, collaborative, and community-driven. Furthermore, teachers need training that extends beyond the technical components and considers how to keep students engaged during remote learning, for example, with trauma-informed methodology (↑Teixeira & Crawford, 2022). Teachers also have needs of their own and require support after climate shocks. This can include access to an online peer community that shares resources and offers support.

Importantly, any TPD programme regarding climate change education should consider teacher workload (↑Ignacio et al., 2023) and should be designed using the pedagogical models articulated in Theme 4A: agency and empowerment, dialogic and collaborative learning, and within the conceptual framework of lifelong learning, which is an important strategy for teachers to adapt to changeable futures and societal needs. Continuous education and access to online learning opportunities (as well as the digital skills required to engage with these) can also support teachers to acquire new skills or roles, which is particularly important in times of uncertainty.

Theme 4C: Community and parental awareness and involvement

The literature emphasises the importance of local and community-oriented policies that involve parents and caregivers in disaster preparedness. A holistic approach to climate change education should emphasise eliciting the participation of wider community members in conversations, as this can lead to more informed decisions on lifestyle and appropriate mitigation strategies (↑Fitzpatrick & Amenya, 2023; ↑Ignacio et al., 2023; ↑Opabola et al., 2023).

EdTech's role within this is to support schools in mobilising knowledge and resources for families, which can enhance their capacity to adapt to changing environmental conditions and protect children during disasters.

For example, this could be achieved through the use of digital platforms to raise awareness about climate risks and preparedness (↑Chirambo, 2018). In addition, ↑Sidze (2016) recommends building an information and knowledge-sharing community-led platform that leverages technologies community members are already familiar with and that mirrors their socio-cultural context. This also requires recognising that climate change education should extend beyond formal systems of education, and ways to integrate it into non-formal education systems should be considered. There is a clear role for public awareness, media, and partnerships in conveying information about climate change mitigation and adaptation as well as promoting climate action, which EdTech may be able to leverage (↑UNESCO, 2015).

Considerations should include the complex relationships within households and communities (↑Fitzpatrick & Amenya, 2023), as well as parents' and caregivers' perceptions of technology, since this affects learners' use of EdTech (↑Tauson & Stannard, 2018).

4. Synthesis and conclusions

The literature reviewed for this study identifies ways in which EdTech may be designed and implemented effectively for the thematic areas discussed above. This section summarises these design considerations for successful interventions (Section 4.1) as well as common barriers to implementation that need to be addressed (Section 4.2). Implications for research, policy and practice, as well as conclusions, are presented in Section 4.3.

4.1 Design considerations for EdTech to build climate resilience

As discussed above, EdTech interventions can play a critical role in supporting climate resilience. Within the above themes, the literature suggests the following characteristics and processes should be emphasised during design and implementation to ensure success. These are closely aligned with the findings from the rapid evidence review on EdTech for education in emergencies by ↑Barnes et al. (2025) and serve to substantiate their research.

The following design considerations offer a synthesis of the insights provided from all the publications included in this evidence review.

Foster collaboration with other sectors and stakeholders

The findings from this review emphasise the need for a multi-level and layered commitment by different government, NGO, and private sector stakeholders alongside learners, teachers, and community members. EdTech interventions for climate resilience should work to foster these partnerships and collaboration.

Include stakeholder voices in the design and implementation of EdTech interventions

Local governments, educators, and community members in communities frequently afflicted by climate shocks should be involved in the design and deployment process to ensure that EdTech solutions are culturally relevant, user-friendly, and supported by adequate training and capacity building.

Utilise context-responsive design

EdTech solutions need to be tailored to local climate risks and infrastructural challenges, for example, using solar-powered digital devices in areas prone to power outages and ensuring offline accessibility in remote regions, allowing interventions to continue if internet connectivity is interrupted. The literature emphasises that there is no one-size-fits-all design for EdTech, as different contexts have different socio-economic, cultural, environmental, and political factors that need to be considered for effective risk reduction and resilience-enhancing strategies (e.g., see ↑Opabola et al., 2023).

Leverage available technology

A guiding principle for EdTech designers is to harness technology that is already familiar and available to the learners. As suggested in the above themes, mobile phones are likely already more available and familiar to intervention users, and WhatsApp groups can be effective avenues for collaboration and knowledge sharing. User-centred design should elicit these perspectives and experiences regarding the type of technology.

Provide quality, continued teacher training and support

For teachers to effectively utilise EdTech in the classroom or community to build climate resilience, they require high-quality training and support. This should include continued support for teachers, especially in the face of climate shocks. Where teacher training is also technologically based, this should draw on the above-mentioned design considerations and wider learning regarding EdTech and teacher professional development. For example, this might include providing peer learning opportunities, integrating with existing training programmes and reflecting policy priorities, offering certification for completion, and designing with the communities that will be using the technology.

Mitigate educational inequity

Design principles that target specific populations, such as girls, learners with disabilities, and learners in remote communities, can be used to mitigate educational inequities and ensure the needs of these learners are considered in the design of the innovation.

Integrate EdTech design with climate-resilient design

This ensures that the technical infrastructure required for EdTech interventions does not exacerbate climate change. This should include utilising existing resources instead of creating new products that will eventually need to be discarded, considering the ways in which infrastructure requires charging and updates, and providing training for school staff to troubleshoot device problems.

Ensure that EdTech design includes the collection, analysis, and dissemination of data

This should be leveraged for improvements to interventions, as well as mobilised to the wider sector to ensure that all related programmes and policies can access current good practice and associated evidence.

In addition to the above design considerations, the literature recommends that the sector **reconsiders the conceptualisation of EdTech**. EdTech does not automatically lead to improved learning outcomes (↑Tauson & Stannard, 2018), and the dominant framing of EdTech as being a ready response to climate problems is perhaps unhelpful (↑Selwyn, 2021). This framing does not account for how technology may contribute to climate change through the resource and energy demands from the production and consumption of digital resources, including the growing problem of e-waste.

This refocusing of EdTech and climate resilience requires collaboration, the co-construction of knowledge through dialogue, and a multilayered commitment, as articulated in the design consideration to foster collaboration with other sectors and stakeholders. Importantly, this should be revisited frequently. EdTech is a subject area where stakeholders engage in questions regarding innovation and change (↑Selwyn, 2021), and this lens should be similarly applied to explore the framing of EdTech itself, actively seeking resolutions to challenges in its conception.

4.2 Barriers to successful implementation

Several challenges and barriers regarding the use of EdTech to build climate resilience exist, which are discussed below. As in the previous section, these points provide a synthesis of insights from the literature included in this review.

Context-related barriers

These include the language and cultural barriers in the development of EdTech-related content, as well as the need for contextualised and locally grounded recovery processes and climate-focused content within digital learning platforms.

Engagement barriers

These extend from discussions about curricula, indicating that curricula often lack interactive and interdisciplinary content, which limits opportunities for students to engage with climate and environmental issues. Resource constraints in LMICs, particularly in remote or vulnerable areas, may further hinder the integration of technology-based climate education that provides more engaging content.

Capacity-related barriers

These include the lack of adequate training opportunities for teachers on using digital technologies and tools for climate education, as well as during a climate shock. There is often limited teacher capacity to effectively implement EdTech solutions in schools and communities. This also includes the heavy workload of teachers, often preventing them from having the capacity to implement EdTech solutions.

Additionally, curricula are already considered overloaded in many contexts, making it a significant challenge to find appropriate space for the addition of climate-related topics. If not approached thoughtfully, the addition of climate topics could sideline other essential foundational skills in the curricula, which are crucial for student development.

The literature also highlights **access barriers** to participation in EdTech interventions. These include the physical resources and digital infrastructure necessary for participation, such as internet connectivity, reliable electricity supply, consistent access to devices, and support for device usage. In addition to such physical resources, learners, caregivers, and teachers need digital literacy skills during climate shocks. The literature highlights access disparities, especially in remote areas and among marginalised communities, which lead to significant digital divides that hinder the equitable deployment of EdTech interventions. The literature also notes gender-based barriers, which prevent female learners from accessing and ultimately benefiting from EdTech interventions following a climate shock. In addition, the psychological impact of climate-related shocks, such as the destruction of homes, affects both students and teachers. This invariably complicates their ability to attend school and engage in learning effectively.

Policy and governance gaps

These gaps include insufficient policy support for integrating technology into national climate resilience strategies, alongside the absence of clear policies to support the integration of climate education through digital tools. This also results in challenges associated with integrating climate resilience into school infrastructure planning.

Financial and resource constraints

Financial and resource constraints include the high costs of disaster-resistant school designs and retrofitting, as well as financial challenges in scaling up technology-enhanced learning initiatives and securing long-term, sustainable funding. For example, ↑Chirambo (2018) highlights the challenges faced by many sub-Saharan African governments in adequately funding and investing in education and skills improvement systems.

4.3 Conclusions and implications for research, policy, and practice

Climate change threatens the educational outcomes of children, particularly in LMICs and the most vulnerable communities. Education has the potential to enhance climate action and resilience through targeted planning for adaptive infrastructure, practice, and policy, and EdTech can play a supportive role in this if designed and implemented strategically. There is an increasing need for climate change education as a tool for both mitigation and adaptation, and as such, there is a role for innovation in teaching and learning approaches to deliver this. Despite these risks and opportunities, education remains largely overlooked within climate discourse, and there is significant room for educational stakeholders to become more active in associated discussions.

This rapid evidence review analysed the key messages present in a selection of existing literature regarding how EdTech can be used to enable climate resilience in LMICs. Using the thematic framework provided by ↑Marin et al. (2024), this review highlights 12 sub-themes that are frequently cited in the literature, which can provide key insights for research, policy, and practice to leverage and build on.

The following points are recommended for research, policy, and practice, based on the findings from this review.

1. Clearer definitions of related terminology are needed

The literature offers varying definitions of infrastructure and resilience, which highlight how stakeholders may similarly define these differently. This may lead to inconsistent approaches in resilience planning and evaluation, and also creates challenges in defining and mitigating associated access barriers (↑Cameron et al., 2024; ↑Luetz, 2020; ↑Mbugua et al., 2024).

2. Empirical robust research that explores and evaluates the use of specific EdTech interventions to build climate resilience is urgently required

Empirical research needs to explore climate change in isolation and not in combination with other learning disruptors. While we recognise the complexity of the learning environment and the invariable interconnectivity between factors that affect and limit access to learning, more evidence that provides explicit links between EdTech interventions and building climate resilience is needed. This can provide a better understanding of how and which technology is the most useful when it comes to facilitating learning. This should also include the storied experiences of all stakeholders, including affected community members; for example, building on the research conducted by ↑Mazari et al. (2022), which collected insights from climate-affected communities in Pakistan.

3. Future evidence and literature reviews should include the large body of research adjacent to this field

While this review offers insights into the use of EdTech in education in emergencies and during the Covid-19 pandemic, these are from publications that also discuss climate change education. Because of the shortage of empirical data regarding the efficacy of EdTech interventions for building climate resilience, we recommend that future evidence reviews incorporate literature that is outside the current review's inclusion criteria. This may help to apply a more theoretical lens to the subject area and can allow for a better understanding of gaps that may lead to misaligned policies and inefficient resource allocation. Including insights from adjacent literature can also support the development of ideas and design principles for related interventions. Theories can then be tested against new and emerging data and evidence that is specific to climate change education.

4. Research should carefully consider the methodological approaches that are most appropriate

This specific area of research may require different methodological approaches to include, for example, innovative conceptual frameworks, policy analyses, or school infrastructure plans. This should be documented and built upon in future studies in order to develop a sound process as a sector to research EdTech and climate, as well as to evaluate it.

5. Long-term, sustainable funding commitments and better cross-sector collaboration are required

These are vital to support impactful interventions that have the time and resources to make changes (↑INEE, 2023; ↑Mbugua et al., 2024). Long-term funding from both public and private sources can also support updating and scaling EdTech interventions. However, this cannot happen without a commitment to building a more comprehensive understanding of how climate resilience can be supported, and the role of EdTech within this, through robust evidence gathering. The four overarching themes used in this review provide a helpful framework for continued research to build upon. Additionally, research and evidence on costing are needed, including cost-benefit analyses of EdTech programmes for building climate resilience.

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These references are available digitally in our evidence library at https://docs.edtechhub.org/lib/D8BJ4AAH

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Annex: Search strings

Theme 1: Education management

Google Scholar

- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (manage OR "education management" OR "disaster risk" OR risk OR "school management")
    - Adjusted string to include the following: AND ("Primary Education" OR "Secondary Education") AND (LMC OR LMCs)
- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND ("early warning system" OR warn OR "EWS")

Google Main

- EdTech education technology digital ICT climate resilience mitigation evidence school education management disaster risk reduction
- EdTech education technology digital ICT climate resilience mitigation evidence early warning system

Theme 2: School infrastructure

Google Scholar

- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (location OR "location planning")
- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (infrastructure OR construct OR build OR retrofit OR shading)
- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR

storm OR cyclone OR drought) AND (school OR education) AND (roof OR ceiling OR wall)

Google main

- EdTech education technology digital ICT climate resilience mitigation evidence location planning
- EdTech education technology digital ICT climate resilience mitigation evidence infrastructure building construction retrofit

Theme 3: Ensuring learning continuity

Google Scholar

- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND ("school closure" OR disrupt OR displace OR "emergency shelter")
- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND ("remote learning" OR "distance learning" OR "online learning")
- ("Educational technology" OR EdTech OR technology OR digital) AND (climate OR climatic OR "natural disaster" OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND ("psychosocial support" OR "SEL" OR "social-emotional learning" OR "mental health" OR psychological)

Google Main

- EdTech education technology digital ICT climate resilience mitigation evidence school closure disruption displacement
- EdTech education technology digital ICT climate resilience mitigation evidence school remote distance online learning
- EdTech education technology digital ICT climate resilience mitigation evidence mental health psychosocial psychological support social-emotional learning

Theme 4: Leveraging students and teachers as change agents

Google Scholar

- (“Educational technology” OR EdTech OR technology OR digital) AND (climate OR climatic OR “natural disaster” OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (student OR “student-led” OR children OR pupil)
- (“Educational technology” OR EdTech OR technology OR digital) AND (climate OR climatic OR “natural disaster” OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (teacher OR staff OR “teacher training” OR “teacher professional development”)

Google Main

- EdTech education technology digital ICT climate resilience mitigation evidence student management knowledge
- EdTech education technology digital ICT climate resilience mitigation evidence teacher management knowledge training development

Additional searches

Additional searches were made on both Google Scholar and Google main to ensure that relevant publications were included:

- Google Scholar
  - (“Educational technology” OR EdTech OR technology OR digital) AND (climate OR climatic OR “natural disaster” OR flood OR heat OR storm OR cyclone OR drought) AND (school OR education) AND (resilience OR mitigation OR mitigate OR vulnerability OR adapt)
  - EdTech OR technology AND (“Climatic resilience” OR “Climate risks” OR “Climate Hazard”) AND (“Primary education” OR “Secondary education”)
  - “educational technology” AND “climate change” AND “primary education” AND “LMICs”

    - EdTech OR “climate change resilience” AND (“primary” OR “secondary education”)

- Google main
    - use of education technology to build climate adaptation or resilience for primary education in LMICs
    - use of education technology to build climate adaptation or resilience for secondary education in LMICs