# Children's agency in climate education: Neuroeducation-informed design principles for southeast Asia

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**Abstract**
Climate change is reshaping children's everyday environments in Southeast Asia by increasing exposure to floods, heat, and environmental degradation, while undermining their well-being and perceived control. The objective of this conceptual article is to develop neuroeducation-informed design principles for climate education to strengthen children's agency and autonomous adaptation in Thailand, Lao PDR, Cambodia, and Viet Nam. Using a narrative, theory-building approach, the methodology involves synthesizing interdisciplinary literature across educational neuroscience, environmental psychology, and child-centered adaptation. The main results present a novel framework that maps emotional regulation, cognitive load management, motivation, and social learning onto the educational purposes of informing, understanding, skill-building, and action. Based on this framework, five design principles are proposed: emotional safety, local and embodied learning, scaffolded action, collaborative and intergenerational learning, and sustained teacher support. The implications of this study suggest that implementing these principles in low-resource, high-risk educational contexts can effectively transition climate education from merely imparting knowledge to fostering psychological resilience and actionable climate agency among vulnerable youth.

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## 1. Introduction

Environmental psychology examines how physical and social environments shape psychological processes and behavior, and how human actions, in turn, transform those environments. In Southeast Asia, this reciprocal relationship is increasingly evident as climate change intensifies floods, heat waves, storms, and other hazards that affect health, education, and everyday life, with children among the most vulnerable groups (Gifford & Steg, 2011; Hickman et al., 2021; UNICEF, 2011; Mohamed et al., 2025). Regional assessments further indicate that Southeast Asia is highly exposed to climate impacts, particularly in coastal and low-lying areas (Economic Research Institute for ASEAN and East Asia [ERIA], 2024; Regional Resource Centre for Asia and the Pacific, 2020). Thailand provides a clear illustration of these pressures. A national assessment by Thailand Development Research Institute and UNICEF Thailand found that children in the Northeastern and Southern regions are especially vulnerable to droughts, heat waves, and floods, identified 10 high-risk provinces under the RCP4.5 scenario for 2016–2035, and called for stronger climate change education and more resilient school infrastructure (Thailand Development Research Institute & UNICEF Thailand, 2022; UNESCO, 2024; United Nations Thailand, 2025). This evidence highlights the need for climate education that addresses both learning and well-being (Clayton, 2020; Hickman et al., 2021; Léger-Goodes et al., 2022; Mohamed et al., 2025).

In response, governments, international agencies, and civil society organizations have introduced climate change education (CCE) and child-centered climate adaptation programs across Southeast Asia to strengthen children's climate knowledge, preparedness, and participation in local adaptation (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; Plan International & ESSA, 2015; Save the Children, 2012, 2015; World Vision Thailand, 2025). Regional initiatives in Indonesia, Lao PDR, Thailand, and Viet Nam, together with evaluations from Viet Nam and child-led studies in Asia, suggest that children can contribute meaningfully to adaptation and disaster risk reduction when supported through school- and community-based programs (Save the Children, 2012, 2015; Rashid et al., 2014; World Vision Thailand, 2025). At the same time, this body of work reveals continuing gaps in curriculum integration, teacher support, and the systematic inclusion of children's voices in formal education (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; Plan International & ESSA, 2015; Save the Children, 2012, 2015). Evidence from Northeast Thailand reinforces this point: a mixed-methods study of 400 teachers identified teacher training, institutional support, and available resources as the main predictors of effective CCE implementation, while rural schools faced substantially greater constraints than urban schools (Meekaew & Saenkum, 2025; Jaelani & Djayaningrat, 2025).

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Despite this growing literature, existing approaches remain fragmented. Current frameworks in climate and environmental education tend to emphasize either psychological processes of learning and emotion or practical adaptation strategies in specific regional contexts, but rarely integrate both within a single framework (Gifford & Steg, 2011; Hickman et al., 2021; Meekaew & Saenkum, 2025; Mohamed et al., 2025). Furthermore, traditional educational models often fail to address the cognitive and emotional load imposed by complex environmental data, representing a critical research gap where knowledge transfer alone is insufficient to drive action (Sweller et al., 2019; Ojala, 2012). State-of-the-art approaches in neuroeducation suggest that optimizing brain-based learning by integrating cognitive and emotional pathways can significantly bridge the gap between environmental knowledge and sustainable behavior (Clayton, 2020; Trott, 2020). However, the application of neuro-educational management and affective processing remains largely absent from climate curricula, particularly in the Global South where resource disparities exacerbate climate vulnerabilities (Pihkala, 2020). This gap limits the development of climate education that is psychologically informed, contextually grounded, and feasible in low-resource, high-risk school settings (ERIA, 2024; Meekaew & Saenkum, 2025; Regional Resource Centre for Asia and the Pacific, 2020).

The primary objective of this conceptual study is to develop neuroeducation-informed design principles for climate education that can strengthen children's agency and autonomous adaptation in Thailand, Lao PDR, Cambodia, and Viet Nam. Specifically, it aims to map emotional regulation, cognitive load management, motivation, and social learning onto four purposes of environmental education informing, fostering understanding, building skills, and supporting action and uses this framework to propose design principles for research and practice in the region (Bandura, 2006; Chawla, 2015; Ryan & Deci, 2000; Gifford & Steg, 2011).

## 2. Method

This article used a narrative, theory-building approach to develop neuroeducation-informed design principles for climate change education in Southeast Asia (Gifford & Steg, 2011; Meekaew & Saenkum, 2025). The research design focused on synthesizing interdisciplinary literature to construct a new conceptual paradigm rather than testing a single empirical hypothesis. The objects of the research included regional climate policy documents, child-centered adaptation programs, and empirical studies on educational neuroscience and environmental psychology. The subjects of the research context were primary and lower-secondary learners (approximately ages 8 to 14) and their teachers in climate-vulnerable, low-resource school settings across Thailand, Lao PDR, Cambodia, and Viet Nam. The aim was to clarify how psychological processes related to learning, emotion, and agency can inform climate education in climate-vulnerable, non-WEIRD school settings (Bandura, 2006; Ryan & Deci, 2000; Pihkala, 2020).

A structured literature search covered three domains: (a) neuroeducation and the learning sciences, (b) environmental and climate change education with attention to psycho-emotional dimensions, and (c) child-centered climate adaptation and climate-related educational programs for primary and lower-secondary learners in Southeast Asia. Searches were conducted in multidisciplinary and education-focused databases, as well as institutional repositories and organizational websites, including ERIA, UNICEF, and regional research centers. Search terms combined neuroeducation, learning sciences, child development, climate change education, environmental education, eco-anxiety, children's agency, autonomous adaptation, child-centered adaptation, and Southeast Asia.

Sources were included if they (a) addressed primary or lower-secondary learners or their teachers, (b) provided conceptual or empirical insights into emotion, motivation, agency, or social learning relevant to climate education, (c) described child-centered adaptation or resilience programs in Thailand, Lao PDR, Cambodia, or Viet Nam, or (d) presented regional or national policy analyses linking climate impacts on children with education systems and adaptation strategies. Brief mentions without substantive analysis were excluded.

The analysis proceeded in three stages. First, it identified key constructs related to emotional regulation, cognitive load management, motivation, and social learning because these shape how children attend to, process, and retain climate-related information and translate learning into action (Bandura, 2006; Chawla, 2015; Ryan & Deci, 2000; Sweller et al., 2019). Second, it mapped these constructs onto four purposes of environmental education: informing, fostering understanding, building skills, and supporting action (ERIA, 2024; Regional Resource Centre for Asia and the Pacific, 2020). Third, it reviewed empirical studies, policy documents, and practice-oriented reports from Southeast Asia to identify recurring patterns, tensions, and promising approaches for refining the proposed design principles (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; ERIA, 2024; Meekaew & Saenkum, 2025; Save the Children, 2012, 2015; Thailand Development Research Institute & UNICEF Thailand, 2022; United Nations Thailand, 2025; World Vision Thailand, 2025). This process produced a heuristic framework and a set of neuroeducation-informed design principles for future research and practice.

## 3. Results and Discussion

The proposed framework links psychological processes involved in children's learning and agency with the purposes and contexts of climate change education in Southeast Asia (Bandura, 2006; Gifford & Steg, 2011; Meekaew & Saenkum, 2025). It treats climate education as an intervention in human-environment relations that shapes how children experience climate risks, understand their causes, and perceive their own capacity to act (Bandura, 2006; Ryan & Deci, 2000; Gifford & Steg, 2011). The framework also recognizes eco-anxiety as a real and growing concern that requires deliberate pedagogical attention in climate education design (Clayton, 2020; Hickman et al., 2021; Kaligis et al., 2024; Léger-Goodes et al., 2022; Ojala, 2012; Pihkala, 2020).

To effectively convey critical environmental science content such as the thermodynamic processes driving global warming, ecosystem degradation, or ocean acidification educators must carefully manage the emotional and cognitive load placed on students (Sweller et al., 2019). Integrating scientific realities with neurocognitive safety ensures that learners are not paralyzed by fear, but are instead motivated to engage with complex Earth systems and sustainable practices (Clayton, 2020; Hickman et al., 2021).

The framework is organized into three interrelated layers. The innermost layer comprises four neurocognitive and affective processes central to climate learning: emotional regulation, cognitive load management, motivation, and social learning (Bandura, 2006; Ryan & Deci, 2000; Chawla, 2015). These processes shape how children attend to, process, and retain climate-related information, and how they integrate emotional responses to climate risks into coherent understandings of themselves and their environments (Bandura, 2006; Ryan & Deci, 2000; Pihkala, 2020). The middle layer connects these processes to four broad purposes of climate and environmental education: informing, fostering understanding, building skills, and supporting action (ERIA, 2024; Regional Resource Centre for Asia and the Pacific, 2020). Each purpose engages a distinct but overlapping set of psychological processes, and neglecting emotional and motivational dimensions can weaken both learning and action. The outer layer situates these interactions within the socio-cultural and policy context of Thailand, Lao PDR, Cambodia, and Viet Nam, including national assessments of climate impacts on children, child-centered adaptation initiatives, and broader education and development agendas (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; ERIA, 2024; Save the Children, 2012, 2015; Thailand Development Research Institute & UNICEF Thailand, 2022; United Nations Thailand, 2025; World Vision Thailand, 2025). This layer highlights how climate education is shaped by climate vulnerability profiles, education system capacity, and school-level resource constraints, especially in low-resource and high-risk settings.

Figure 1 illustrates the proposed three-layered neuroeducation-informed framework for children's climate education in Southeast Asia. As depicted in Figure 1, the model is structured concentrically to show how climate vulnerability profiles and regional policies (outer layer) influence educational purposes (middle layer), which must all be processed through the learner's neurocognitive and affective processes (innermost layer) to be effective. The bidirectional arrows indicate that climate education shapes children's psychological engagement and perceived agency, while these processes also influence how children interpret and respond to climate education in specific socio-ecological settings (ERIA, 2024; Meekaew & Saenkum, 2025; Regional Resource Centre for Asia and the Pacific, 2020; Save the Children, 2012; Thailand Development Research Institute & UNICEF Thailand, 2022).

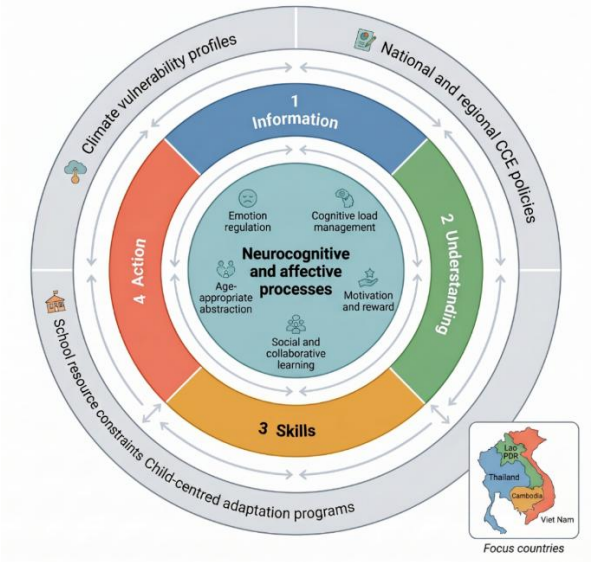


**Figure 1. Three-Layered Neuroeducation-Informed Framework for Children's Climate Education in Southeast Asia**

Building on the conceptual framework, five design principles are proposed for climate education targeting primary and lower-secondary learners in Thailand, Lao PDR, Cambodia, and Viet Nam (Meekaew & Saenkum, 2025; ERIA, 2024). Table 1 details these Neuroeducation-Informed Design Principles for Children's Agency in Climate Education in Southeast Asia. As outlined in Table 1, each principle maps a specific psychological process to an educational purpose and provides concrete contextual applications. For example, the principle of 'Local and Embodied Learning' leverages motivation and memory consolidation to foster understanding, suggesting that educators anchor scientific lessons to observable local phenomena, such as seasonal floods and regional biodiversity, to make abstract climate concepts tangible and actionable. In summary, emotional safety and cognitive load management address overwhelm and disengagement; local and embodied learning makes climate change tangible and meaningful; scaffolded action nurtures agency; and teacher support and low-resource design make the approach feasible in vulnerable school contexts (Bandura, 2006; Ryan & Deci, 2000; Chawla, 2015; Meekaew & Saenkum, 2025).

**Table 1. Neuroeducation-Informed Design Principles for Children's Agency in Climate Education in Southeast Asia**

| Principle | Psychological Process | Educational Purpose | Contextual Application |
|---|---|---|---|
| Emotional Safety First | Emotional regulation; stress management | Informing without inducing eco-anxiety | Use local stories; avoid catastrophic imagery in Thai, Lao, Khmer, and Vietnamese classrooms |
| Local and Embodied Learning | Motivation; memory consolidation | Building understanding through lived experience | Anchor lessons to seasonal floods, heatwaves, and biodiversity familiar to students |
| Scaffolded Action Opportunities | Self-efficacy; agency; mastery experiences | Developing skills; enabling action | School gardens, community risk mapping, and peer-led projects in rural, low-resource schools |
| Collaborative and Intergenerational Learning | Social learning; cultural transmission | Building understanding; enabling action | Involve elders, parents, and community leaders alongside teachers |
| Teacher Professional Support | Cognitive load management for teachers | All four purposes | Ongoing PD modules; urban-rural equity in training access (Meekaew & Saenkum, 2025) |

Scaffolded action is a pedagogical design approach that provides children with structured opportunities to make meaningful choices and perform real-world climate-related tasks of increasing difficulty, with adult support and formative feedback, so that recurring mastery experiences develop self-efficacy and perceived agency over time (Bandura, 2006; Ryan & Deci, 2000). Unlike general calls for student participation, scaffolded action requires the deliberate sequencing of task complexity, explicit linkage between individual action and collective outcomes, and recognition of children as active decision-makers rather than passive beneficiaries of adult-designed programs (Bandura, 2006; Save the Children, 2012; World Vision Thailand, 2025).

The framework has specific implications for climate change education and child-centered adaptation in Thailand, Lao PDR, Cambodia, and Viet Nam. National impact assessments in Thailand identify ten provinces in the Northeast and South as high risk for children under a moderate emissions scenario and recommend strengthening climate change education and resilient school infrastructure as key responses (Thailand Development Research Institute & UNICEF Thailand, 2022; United Nations Thailand, 2025). Embedding the design principles into curriculum development and teacher professional learning in these provinces may help ensure that climate lessons are rooted in children's lived experiences of droughts, floods, and heat waves while also supporting emotional safety and a sense of agency (Meekaew & Saenkum, 2025; Jaelani & Djayaningrat, 2025).

Further evidence from Northeast Thailand suggests that targeted teacher training and institutional support are necessary conditions for successful implementation, especially in rural schools facing large resource gaps (Meekaew & Saenkum, 2025; Jaelani & Djayaningrat, 2025). Regional policy and program documents increasingly position children and young people as active participants in climate adaptation, disaster risk reduction, and community resilience, highlighting the relevance of climate education to broader sustainability agendas in Southeast Asia (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; ERIA, 2024; Save the Children, 2012; World Vision Thailand, 2025).

Evaluations of child-centered climate resilience programs in Viet Nam suggest that school- and community-based activities can increase children's knowledge of climate-related issues and participation in local adaptation planning, but also that these programs need stronger integration into national curricula and sustained teacher support (Save the Children, 2015; World Vision Thailand, 2025). Applying the principles of neuroeducation to these programs would require intentional attention to children's emotional responses, systematic opportunities for decision-making and action, and affordable place-based activities that can be sustained across diverse school settings (Chawla, 2015; Hickman et al., 2021; Monroe et al., 2019; Pihkala, 2020; Trott, 2020).

Child-centered adaptation projects in several countries and school-level initiatives under regional programs in Lao PDR and Cambodia show promise in engaging children as active participants in community risk mapping and adaptation planning, while also revealing capacity gaps in education systems and local institutions (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022; ERIA, 2024; Save the Children, 2012). For these countries, the framework emphasizes the importance of climate education that is feasible in low-resource schools, builds on local knowledge and cultural narratives, and is supported by coherent policies that recognize children as agents in climate adaptation (ERIA, 2024; Meekaew & Saenkum, 2025; World Vision Thailand, 2025).

The framework also offers a psychologically informed lens for evaluating existing climate change education materials and programs. Environmental psychologists and practitioners can use the design principles as a checklist to examine whether interventions provide emotional safety, connect climate concepts to children's everyday environments, scaffold meaningful opportunities for action, and acknowledge local cultural narratives and resource conditions (Chawla, 2015; ERIA, 2024; Meekaew & Saenkum, 2025). Lessons that emphasize catastrophic climate scenarios without clear coping strategies or examples of successful local adaptation should be revised to include guided emotional reflection and locally rooted stories of community resilience drawn from national assessments and child-centered research (Hickman et al., 2021; Ojala, 2012; Pihkala, 2020; Thailand Development Research Institute & UNICEF Thailand, 2022; World Vision Thailand, 2025). Evidence on the benefits of direct contact with nature also supports outdoor, place-based activities as a way to foster environmental identity and positive affect toward nature (Chawla, 2015; Trott, 2020).

This framework further underscores the importance of integrating psychological knowledge into teacher professional development and program design. Training modules for teachers and nonformal educators can include content on managing cognitive load when explaining complex climate processes, recognizing and supporting children's emotional responses to climate-related events, and facilitating collaborative projects that build agency in low-resource settings (Jaelani & Djayaningrat, 2025; Meekaew & Saenkum, 2025; Sweller et al., 2019). Finally, the framework invites environmental psychologists to work more closely with children and young people as co-researchers and co-designers of climate education and adaptation projects, building on emerging child-led research in the region (Save the Children, 2012; World Vision Thailand, 2025).

## 4. Conclusion

This article developed neuroeducation-informed design principles for climate change education to strengthen children's agency and autonomous adaptation in Southeast Asia (Bandura, 2006; Meekaew & Saenkum, 2025; ERIA, 2024). By integrating insights from environmental psychology, climate change education, and child-centered adaptation, the study offers a framework that connects emotional regulation, cognitive load management, motivation, and social learning to the educational purposes of informing, fostering understanding, building skills, and supporting action in Thailand, Lao PDR, Cambodia, and Viet Nam (Bandura, 2006; Gifford & Steg, 2011; Ryan & Deci, 2000; ERIA, 2024). Its main contribution lies in linking psychological processes with regionally grounded climate education design in low-resource, high-risk school settings (Meekaew & Saenkum, 2025; Regional Resource Centre for Asia and the Pacific, 2020). This perspective is important because it frames climate education not only as a way of improving climate literacy but also as a means of supporting children's well-being and strengthening their capacity to participate in adaptation and collective action (Clayton, 2020; Hickman et al., 2021; Mohamed et al., 2025; Ojala, 2012; UNESCO, 2024). At the same time, the framework remains a conceptual contribution and is limited by the uneven availability of research across Southeast Asian contexts and by its reliance primarily on English-language sources (ERIA, 2024; Regional Resource Centre for Asia and the Pacific, 2020). Future research should test and refine these design principles through longitudinal, mixed-methods, and participatory studies that examine how they shape children's emotions, perceived agency, and adaptation practices across diverse educational settings in the region (Meekaew & Saenkum, 2025; Jaelani & Djayaningrat, 2025; Mohamed et al., 2025).

## Author Contributions

Suamuang Ruangrit: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Visualization, Writing – original draft, Writing – review & editing.

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## Declaration of Conflicting Interests

The author declares no competing interests.

## Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

## Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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