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Research Article

Enhancing Conceptual Understanding of Climate Change in Non-Science Preservice Teachers Using DIY Model Kits

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Abstract. Climate change education is critical for improving climate literacy; however, non-science preservice teachers often hold persistent misconceptions that limit their instructional readiness. This study examined the effectiveness of low-cost DIY Model Kits in enhancing conceptual understanding of climate change among 45 non-science preservice teachers with limited exposure to climate science. Participants engaged in three inquiry-based activities via DIY model kits addressing greenhouse gases and the greenhouse effect, global warming and urban heat islands, and climate change–related natural disasters. The experimental models revealed clear cause–effect patterns, including progressively greater temperature increases with increasing CO_2 concentration, minimal temperature change in non-greenhouse gas conditions, and higher heat accumulation in built environments compared with vegetated models. The statistical methods used for data analysis were clearly specified, including the dependent samples *t*-test and normalized gain. Conceptual understanding was assessed using 10 items of the Conceptual Test of Climate Change (CTCC) through a one-group pretest–posttest design. Results showed a statistically significant increase in total CTCC scores from 28.64% (mean = 8.02, S.D. = 2.59) on the pretest to 84.93% (mean = 23.78, S.D. = 2.27) on the posttest ($p < 0.05$), with a high normalized gain ($\langle g \rangle = 0.79$). These findings demonstrate that inquiry-based DIY model kits can effectively support conceptual change and strengthen climate literacy among non-science preservice teachers.

Keywords: DIY climate change kits; Non-Science Preservice Teachers; Conceptual Understanding

INTRODUCTION

Climate change poses severe threats to ecosystems, human health, and global sustainability, demanding urgent societal responses, including within education, which plays a critical role in preparing future generations to understand and respond to this crisis (Abbass et al., 2022). Despite growing public awareness, research consistently shows that students' climate literacy remains insufficient, limiting their ability to make informed decisions and engage in sustainable behaviors (Ramos & Rodrigues, 2024). Climate change education (CCE) presents particular instructional challenges because it requires learners to integrate complex scientific concepts across multiple Earth systems, temporal and spatial scales, and feedback mechanisms. Consequently, effective CCE emphasizes the development of conceptual understanding, systems thinking, and evidence-based reasoning rather than rote memorization. Recent reviews highlight the importance of instructional approaches such as inquiry-based learning, project-based learning, and community-connected learning to support learners in constructing scientifically accurate understandings of climate systems and their societal implications (Monroe et al., 2017; Rousell & Cutter-Mackenzie-Knowles, 2020; Luthfia, 2025).

Empirical studies indicate that many learners struggle to understand fundamental climate change terminology, leading to persistent misconceptions and reduced effectiveness of scientific communication (Bruine de Bruin et al., 2021). Climate understanding is also influenced by cultural and social contexts, demonstrating that increased factual knowledge does not necessarily translate into meaningful climate-related action (Alexandra, 2021). Although children and adolescents often express concern about climate change, misconceptions about its causes, impacts, and mitigation strategies remain widespread, and willingness to engage in climate action may decline with age (Lee et al., 2020). School-based research further reveals that learners may possess fragmented factual knowledge while lacking deeper systems thinking, highlighting a persistent gap between climate awareness and climate-friendly behaviors (Feldbacher et al., 2024). These challenges are especially significant in teacher education, as teachers' conceptual understanding directly influences how climate change is framed, taught, and interpreted in classrooms.

Research on preservice teachers shows that misconceptions about climate-related phenomena, particularly the greenhouse effect and global warming, are common and resistant to change. Early studies documented misunderstandings among preservice teachers regarding atmospheric processes and human contributions to climate change (Khalid, 2001; Çelikler, 2011). More recent research indicates that although many preservice teachers express strong concern about climate change, their conceptual understanding and pedagogical readiness remain uneven (Boon, 2016; Tolppanen et al., 2021). This mismatch between concern and understanding suggests that traditional instruction may be insufficient for promoting meaningful conceptual change and highlights the need for instructional approaches that actively engage preservice teachers in reasoning about causal mechanisms and evidence.

During the COVID-19 pandemic, rapid shifts to remote and hybrid instruction accelerated the adoption of digital and hands-on learning tools to support science education. Abriata (2022) reported that teachers creatively employed DIY tools, smartphone sensors, and simulations to maintain meaningful practical science experiences during periods of restricted classroom access. Hands-on learning resources, including portable science kits, have been shown to enhance student engagement and learning outcomes and to support knowledge retention beyond initial instruction (Foley et al., 2013). In technology-enhanced STEM education, low-cost learning kits and DIY tools have also been found to support inquiry processes by enabling learners to manipulate variables, observe outcomes, and test explanations (Bajracharya et al., 2021; Li et al., 2022). These characteristics align closely with the goals of inquiry-based learning, which emphasizes question generation, evidence collection, explanation, and reflection.

However, while DIY kits and hands-on tools have been widely applied in general STEM education, relatively few studies have examined their use specifically for climate change learning. Climate change concepts are highly abstract and system-oriented, requiring learners to reason about invisible processes and long-term interactions. Inquiry-based learning has been identified as a promising approach for CCE because it allows learners to actively explore cause–effect relationships, confront misconceptions, and construct explanations grounded in evidence (Monroe et al., 2017). From a theoretical perspective, conceptual change theory explains how learners replace existing misconceptions with scientifically accepted conceptions through experiences that create cognitive conflict and promote restructuring of prior knowledge (Posner et al., 1982). Inquiry-based learning environments are particularly well suited to support this process by engaging learners in investigating phenomena, testing ideas, and revising explanations based on evidence.

Despite increasing attention to climate change education, several research gaps remain. First, a population gap persists, as much of the existing research focuses on school students or preservice science teachers, while non-science preservice teachers remain underrepresented in empirical studies (Boon, 2016; Tolppanen et al., 2021). Second, a knowledge gap exists concerning interventions that explicitly target conceptual understanding and causal reasoning in climate science, as many studies emphasize attitudes or general awareness rather than coherent mental models of climate mechanisms (Khalid, 2001; Bruine de Bruin et al., 2021). Third, an empirical gap remains regarding the effectiveness of low-cost DIY instructional interventions designed specifically for climate change learning within teacher education contexts (Foley et al., 2013; Abriata, 2022). Finally, a methodological gap is evident, as relatively few studies employ quantitative pre- and post-test designs to examine conceptual change resulting from inquiry-based climate instruction among preservice teachers.

Addressing these gaps is essential for strengthening teacher preparation programs, particularly for non-science majors who may have limited formal training in climate science but will play an important role in shaping public understanding of climate issues. Accordingly, this study investigates the effectiveness of DIY climate change kits implemented through inquiry-based learning in enhancing non-science preservice teachers' conceptual understanding of key climate change concepts, grounded in conceptual change theory (Posner et al., 1982). This study extends existing climate change education research by providing empirical evidence on the effectiveness of inquiry-based, low-cost DIY climate model kits for enhancing conceptual understanding among non-science preservice teachers in a Thai teacher education context.

RESEARCH QUESTIONS

The aim of this study was to examine the effectiveness of DIY Climate Change Kits implemented through inquiry-based learning in supporting non-science preservice teachers' understanding of climate change. Specifically, the two research questions were posed:

1. To what extent do inquiry-based DIY Climate Change Kit activities demonstrate observable cause–effect relationships in key climate processes?

2. To what extent does the DIY Climate Change Kit intervention improve non-science preservice teachers' conceptual understanding of climate change?

METHODOLOGY

This study employed a quantitative one-group pretest–posttest design to examine preliminary instructional effectiveness under authentic classroom conditions typical of non-science teacher education programs. The study consisted of two key phases: (1) the development of DIY Climate Change Kit activities, and (2) the implementation of these activities to enhance student teachers' conceptual understanding of climate change within the sample group. The effectiveness of the DIY Climate Change Kits was evaluated by comparing the average pre-test and post-test scores of the participants. The intervention was conducted over three lesson plan activities at Chanthaburi College of Dramatic Arts, Chanthaburi, Thailand, during June–July 2024, with the researcher serving as the instructor for the activities. To ensure systematic improvement, quantitative statistical findings were directly compared to assess the learning outcomes. The overall research process is illustrated in Figure 1.

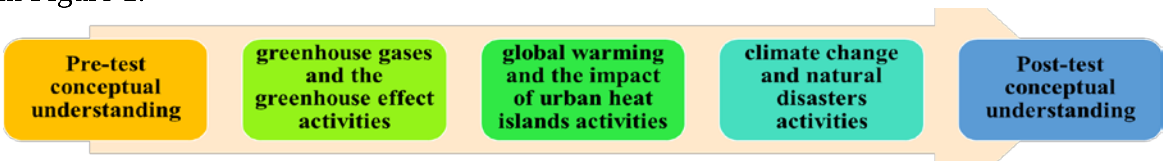

Figure 1. Process of the methodological approach: enhancing conceptual understanding through activities using DIY Climate Change Kits.

Participants

This study involved 45 student teachers enrolled in the Music Education and Thai Dance Education programs at Chanthaburi College of Dramatic Arts, Thailand. These participants represent non-science preservice teachers who typically receive limited formal instruction in climate science as part of their teacher education curriculum. All participants were registered in the Science and Technology in the Digital Age course during the second semester of the 2024 academic year, which provides interdisciplinary exposure to scientific and technological issues relevant to contemporary society. The participants were purposively selected to reflect a population that is often underrepresented in climate change education research but is likely to encounter climate-related topics in future teaching contexts. Participation was voluntary and anonymous, and purposive sampling was employed to ensure alignment between the study objectives and the participants' educational background.

Research Tools

To evaluate the impact of the DIY Climate Change Kits, two quantitative instruments were employed.

1) The DIY climate change activity kit provides a total of 12 hours of instruction, including 3 hours on greenhouse gases and the greenhouse effect, 6 hours on global warming and the urban heat island phenomenon, and 3 hours on climate change and related natural disasters. This initiative was developed by the Department of Climate Change and Environment (DCCE, 2020).

2) Conceptual Test of Climate Change (CTCC): The CTCC contained 10 multiple-choice items covering three domains: (a) greenhouse gases and the greenhouse effect 4 items, (b) global warming and urban heat islands 4 items, and (c) broader climate processes 2 items. Items were adapted from Leiserowitz et al. (2011), content validity was reviewed by three experts in climate education, and item clarity was confirmed through pilot testing with a comparable learner group. and refined for the Thai context. Each item included one correct response and three distractors based on common misconceptions. Pilot testing produced difficulty indices (0.30–0.75), discrimination indices (0.50–0.68), and reliability (KR-20 = 0.79).

Data Collection

Ethical approval for this study was obtained from the Human Research Ethics Committee of Ubon Ratchathani University (Approval No. UBU-REC-29/2567). To preserve natural classroom conditions, data collection was conducted during regular course sessions of the Science and Technology in the Digital Age course. The data collection process consisted of three sequential stages. First, participants completed the Conceptual Test of Climate Change (CTCC) as a pre-test prior to the intervention (approximately 30 minutes). Second, participants engaged in three inquiry-based learning activities using the DIY Climate Change Kits. The activities were structured according to the 5E inquiry learning cycle (Bybee, 2014): the Engagement phase introduced real-world climate-related scenarios to elicit prior knowledge; the Exploration phase involved constructing and experimenting with DIY climate models; the Explanation phase required group discussion and presentation of observed results; the Elaboration phase encouraged comparison of experimental outcomes with scientific explanations and real-world climate data; and the Evaluation phase focused on reflection and discussion of climate-related implications. Finally, after completion of all inquiry activities, participants completed the same CTCC as a post-test (approximately 30 minutes) to assess changes in conceptual understanding. A six-item semi-structured interview protocol was designed to capture pre-service teachers' perceptions of the climate change learning activities. The interview questions were reviewed by the research advisor to ensure content validity and linguistic clarity. Following the completion of the instructional activities, in-depth interviews were conducted with six pre-service teachers, comprising three students with high achievement scores and three students with low achievement scores. The interview data were subjected to interpretive qualitative analysis, and the findings are reported in a descriptive narrative format.

Data Analysis

Quantitative data were analyzed to evaluate the effectiveness of the DIY Climate Change Kits in enhancing non-science preservice teachers' conceptual understanding of climate change. Descriptive statistics, including mean and standard deviation, were calculated for pre-test and post-test CTCC scores. A dependent sample t-test was conducted to determine whether the observed differences between pre-test and post-test scores were statistically significant at the 0.05 level. In addition, normalized gain (<g>) was calculated to assess the magnitude of learning improvement (Christman et al., 2024) across three conceptual domains: greenhouse gases and the greenhouse effect, global warming and urban heat islands, and climate change processes. All statistical analyses were performed using Microsoft Excel, and the assumptions for dependent-sample t-tests were examined prior to analysis. Interpretation of learning gains followed established criteria, with <g> values greater than 0.7 indicating high conceptual improvement.

RESULTS AND DISCUSSION

The results are presented in relation to the two research questions, addressing (RQ1) the extent to which the inquiry-based activities demonstrate observable cause–effect relationships in key climate processes and (RQ2) the effectiveness of the DIY Climate Change Kit intervention in improving conceptual understanding.

Cause–Effect Relationships in Climate Processes Using DIY Climate Change Kits

The inquiry-based DIY Climate Change Kit activities were implemented with 45 non-science preservice teachers across three climate change learning sessions, each lasting three hours. The instructional design aimed to support participants in exploring core climate mechanisms through hands-on investigation and guided inquiry. In the first session, participants engaged in an activity designed to illustrate greenhouse gases and the greenhouse effect, adapted from the DIY Climate Change Kits developed by the Department of Climate Change and Environment (DCCE, 2020). Subsequent sessions focused on global warming and the urban heat island phenomenon, as well as climate change–related natural disasters. Throughout the intervention, participants constructed and used physical models as inquiry tools to observe phenomena, collect data, and reason about cause–effect relationships (Figure 2).

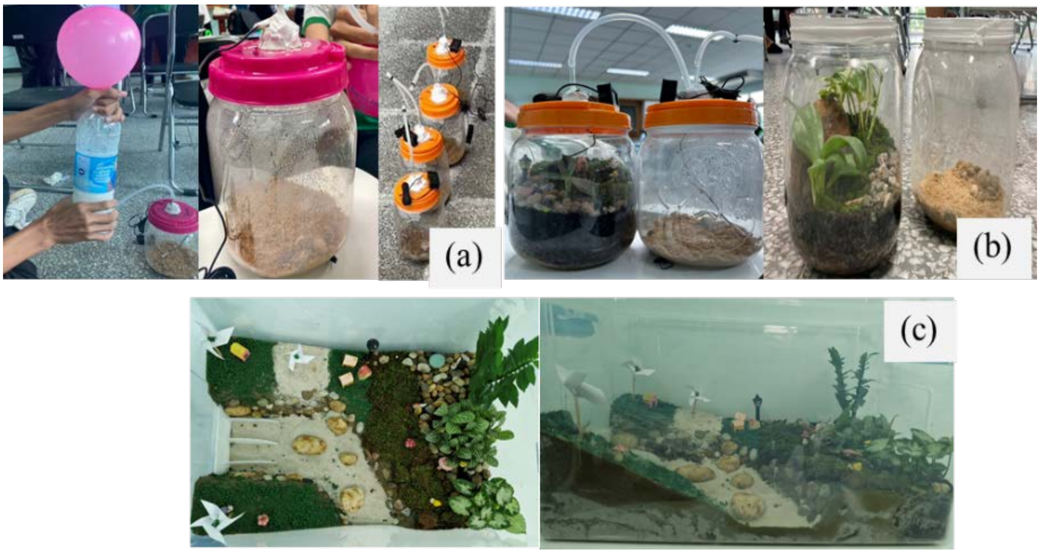

Figure 2. DIY Climate Change Kits for exploring greenhouse gases and the greenhouse effect (a), global warming and the impact of urban heat islands (b), and climate change and natural disasters(c).

Results from the greenhouse gas activity demonstrated a clear pattern of temperature change across different atmospheric conditions (Table 1). Models representing a normal atmosphere showed only modest temperature increases over time, whereas models with added CO_2 exhibited progressively larger temperature increases, with the greatest rise observed when CO_2 concentration was doubled. In contrast, models containing added O_2 showed relatively minimal temperature change. These findings align with established scientific explanations of the greenhouse effect and provide tangible evidence of the heat-trapping properties of greenhouse gases. Similar instructional approaches have been shown to help learners differentiate between greenhouse and non-greenhouse gases by linking abstract atmospheric processes to observable outcomes (Khalid, 2001; Bruine de Bruin et al., 2021).

In the urban heat island activity, models simulating vegetated environments experienced smaller temperature increases than those representing built environments composed of materials such as bricks and stones. This pattern reflects well-documented differences in heat absorption and retention between natural and urban surfaces and mirrors findings from environmental and geography education research on urban heat islands (Feldbacher et al., 2024). The use of simplified physical models enabled participants to visualize how land-use characteristics influence local temperature patterns, supporting inquiry-based reasoning about real-world climate phenomena.

The third activity, focusing on climate change and natural disasters, allowed participants to explore hydrological impacts through a dam-and-river model. Observations of water overflow and flooding after simulated rainfall helped illustrate the relationship between extreme weather events, infrastructure capacity, and downstream impacts on communities and agricultural areas. Such experiential representations are particularly valuable for non-science learners, as they support understanding of complex climate impacts that are often difficult to grasp through text-based instruction alone. Collectively, these findings are consistent with prior studies showing that hands-on, low-cost instructional tools can enhance engagement and support conceptual understanding in STEM and environmental education (Foley et al., 2013; Abriata, 2022).

Table 1. Experimental results from the DIY Climate Change Kits of greenhouse effect, urban heat islands, and natural disasters.

Model / **Times (min)**	**Temperature inside the model (°C)**				
	0	**15**	**30**	**45**	**60**
Model 1: Exploring greenhouse gases and the greenhouse effect					
Model 1.1 Normal atmosphere	35.0	35.3	35.6	36.5	37.2
Model 1.2 Filled with CO_2 gas	35.0	36.5	37.0	37.6	38.8
Model 1.3 Filled with 2 times the CO_2 gas of Model 1.2	35.0	36.9	38.0	41.0	42.2
Model 1.4 Filled with O_2 gas	35.0	35.1	35.5	36.0	36.5
Model 2: Investigating global warming and the impact of urban heat islands					
Model 2.1 Environment with plant and moss	24.0	24.8	25.7	26.3	26.7
Model 2.2 Environment with brick, stones	24.0	26.8	27.5	27.8	27.9
Model 3: Investigating climate change and natural disasters					
Model 3.1 Before the rain	The model represents a dam in the center for water storage, with a river flowing from the dam. Farming areas and houses are situated on both sides.				
Model 3.2 After the rain	The dam reached its capacity, water started overflowing. The water gradually turned brown and eventually spilled over, flooding the nearby houses and agricultural areas.				

* Models 1.1 - 2.2 have a temperature error of no more than ± 0.5.

Importantly, the inquiry-based nature of the activities encouraged participants to generate questions, test explanations, and reflect on observed outcomes, aligning with recommendations for participatory and action-oriented climate change education (Rousell & Cutter-Mackenzie-Knowles, 2020). By making climate mechanisms observable and open to investigation, the DIY Climate Change Kits helped participants confront initial misconceptions and construct more coherent explanations of climate processes. During model-based experimental activities, explicit emphasis must be placed on procedural accuracy for students. Nevertheless, minor discrepancies may still arise as a result of incomplete adherence to the prescribed model procedures established by the instructor.

Non-Science Preservice Teachers' Conceptual Understanding of Climate Change

Quantitative analysis of Conceptual Test of Climate Change (CTCC) scores revealed substantial improvements in participants' conceptual understanding following the inquiry-based intervention (Table 2). Prior to the activities, participants demonstrated low overall performance, with a mean pre-test score of 8.02 (28.64%), reflecting limited understanding of key climate concepts. After completing the DIY Climate Change Kit activities, the mean post-test score increased to 23.78 (84.93%), representing a statistically significant improvement ($p < 0.05$). The overall normalized gain (<g> = 0.79) indicates a high level of conceptual improvement. When examined by content domain, similar patterns of improvement were observed. Participants showed low pre-test performance across greenhouse gases and the greenhouse effect (GG and GE), global warming and urban heat islands (GW and UHI), and broader climate change processes (CC). Post-test results demonstrated marked gains in all three domains, with normalized gains ranging from <g> = 0.76 to <g> = 0.87. To ensure consistency in measurement, the same test instrument was employed for both the pre-test and post-test, with the order of questions and answer choices randomized in the post-test. The post-test was administered after the completion of Learning Activity 3, following a total instructional duration of four weeks. These findings suggest that the inquiry-based DIY activities were effective in supporting conceptual change across multiple aspects of climate science.

Table 2. Non-Science Preservice Teachers' pre- & post test scores of the conceptual understanding on climate change

Conceptual understanding	mark	Pre-Test			Post-Test			<g>	t-test	
		mean	S.D.	%	mean	S.D.	%		t	*p*-value
GG and GE	10	2.62	1.19	26.20	8.33	1.41	83.30	0.77	22.53	0.000*
GW and UHI	7	3.07	1.32	43.86	6.49	0.63	92.71	0.87	19.83	0.000*
CC	11	2.33	1.68	21.18	8.96	1.68	81.45	0.76	22.05	0.000*
Total	**28**	**8.02**	**2.59**	**28.64**	**23.78**	**2.27**	**84.93**	**0.79**	**34.61**	**0.000***

* Statistically significant at p-value 0.05.

Note: GG and GE = greenhouse gases and greenhouse effect, GW and UHI = global warming and urban heat island, and CC = climate change.

Although the GW and UHI topics are allocated a lower overall score (7 points), they are intentionally structured to promote higher-order cognitive engagement, such as analytical thinking and evaluative reasoning. Meeting these cognitive requirements involves a longer instructional duration, particularly through group-based activities and classroom discussions, amounting to six hours of instruction. In contrast, the GG and GE topics are assigned a higher total score (10 points) but predominantly emphasize theoretical understanding and core conceptual knowledge. As foundational content, these topics can be delivered within a shorter instructional period of three hours; however, their fundamental importance justifies assessment across multiple aspects of understanding. These results are consistent with prior research indicating that preservice teachers often enter teacher education programs with fragmented or incorrect understandings of climate-related concepts (Khalid, 2001; Çelikler, 2011; Boon, 2016). The significant learning gains observed in this study support the argument that inquiry-based, hands-on instruction can help address these misconceptions by allowing learners to actively engage with evidence and revise their prior conceptions. Similar improvements in conceptual understanding have been reported in studies using hands-on kits and inquiry-oriented approaches in science education (Foley et al., 2013; Abriata, 2022). Moreover, the high normalized gain suggests that the intervention supported not only factual learning but also deeper reasoning about causal relationships within climate systems. This aligns with research emphasizing the role of inquiry-based learning in promoting systems thinking and meaningful engagement with climate issues (Rousell & Cutter-Mackenzie-Knowles, 2020; Feldbacher et al., 2024). Given that misconceptions among future teachers can negatively influence classroom instruction and public understanding of climate science (Bruine de Bruin et al., 2021), the observed improvements highlight the potential value of integrating inquiry-based climate activities into non-science teacher education programs.

Taken together, the results addressing RQ1 and RQ2 suggest a clear relationship between observable inquiry experiences and conceptual learning outcomes. The cause–effect patterns demonstrated through the DIY Climate Change Kit activities (RQ1) provided concrete experiential evidence that supported preservice teachers in revising prior misconceptions and constructing more coherent explanations of climate processes. These inquiry experiences appear to underpin the substantial gains in conceptual understanding measured by the CTCC (RQ2), indicating that engaging learners in hands-on investigation of climate mechanisms is an effective pathway for promoting conceptual change. This alignment between process-level evidence and learning outcomes reinforces the value of inquiry-based instructional designs for climate change education, particularly for learners with limited prior science backgrounds.

The significant learning gains observed in this study are consistent with national education goals articulated in Thailand's Basic Education Core Curriculum B.E. 2551 (A.D. 2017), which emphasizes the development of essential knowledge, thinking skills, and scientific understanding to prepare learners for a rapidly changing society, including environmental and sustainability challenges (Office of the Basic Education Commission, 2017). The Curriculum includes environmental education within science learning standards and supports inquiry and problem-solving approaches that foster meaningful engagement with real-world phenomena such as climate variation and Earth processes, thus aligning with the inquiry-based learning design used in this study. Moreover, Thailand's participation in international frameworks such as Sustainable Development Goal 4 (Quality Education) and its commitment to mainstreaming environmentally informed approaches in education further reinforce the importance of strengthening climate literacy and teacher preparation through hands-on, evidence-based instructional strategies

A comprehensive examination of the improvement and development associated with the DIY Climate Change Kit activities was conducted using semi-structured interviews. Interpretations were derived from student teachers' responses to the interview questions. The findings indicate that group work and simulation-based activities foster skill development and promote an engaging, iterative learning process. Moreover, well-structured activities support deeper conceptual understanding while strengthening essential competencies, thereby effectively preparing students to address real-world challenges. Through participation in the DIY Climate Change Kit activities, student teachers demonstrated a heightened awareness of climate change, including its global impacts and the role of human actions in contributing to environmental problems. They also became more reflective about their daily behaviors and recognized how small behavioral changes can contribute to climate change mitigation. In particular, activities focusing on global warming and urban heat islands emphasized the influence of human activities on the environment and encouraged the adoption of practical solutions, such as reducing unnecessary use of air conditioning. Overall, these activities effectively enhanced climate change awareness and motivated student teachers to take proactive actions in their everyday lives to address climate-related issues.

CONCLUSION AND IMPLICATIONS

This study investigated the effectiveness of inquiry-based DIY Climate Change Kits in enhancing non-science preservice teachers' conceptual understanding of climate change. The findings demonstrate that low-cost, hands-on inquiry activities can successfully support learners in observing and reasoning about key climate mechanisms, including the greenhouse effect, urban heat islands, and climate-related natural disasters. Experimental results from the DIY models revealed clear cause–effect relationships, while quantitative analyses showed statistically significant improvements in conceptual understanding with a high normalized gain. The results indicate that inquiry-based learning supported by DIY climate models can reduce common misconceptions and promote more coherent and scientifically accurate understandings of climate processes among non-science preservice teachers. Given that this population often receives limited formal instruction in climate science but plays an important role in future interdisciplinary teaching contexts, the use of accessible and scalable instructional tools is particularly valuable. Overall, this study contributes empirical evidence to climate change education research by addressing gaps related to learner population, instructional approach, and assessment of conceptual change. The findings indicate that inquiry-based learning using DIY climate model kits can effectively enhance non-science preservice teachers' understanding of complex climate mechanisms and reduce persistent misconceptions. Given the interdisciplinary teaching roles of non-science preservice teachers, integrating such inquiry-based climate activities into teacher education programs may strengthen climate literacy across subject areas. Beyond climate change education, this instructional approach may be adapted to other complex socio-scientific issues to support conceptual understanding and scientific reasoning in non-science teacher education contexts.

The findings of this study provide important implications for science education, particularly in preparing non-science preservice teachers to teach climate change effectively. The significant conceptual gains observed after using DIY Climate Change Kits suggest that the low-cost hands-on inquiry activities should be more widely integrated into teacher education programs to strengthen climate literacy and reduce misconceptions. These results highlight that experiential learning can help future teachers develop accurate mental models of greenhouse gases, urban heat islands, and climate-related natural disasters—concepts that are often difficult to grasp through traditional instruction. Implementing DIY kits can also promote scientific reasoning and systems thinking, supporting 21st-century teaching competencies. Therefore, curriculum designers, science educators, and policy makers should consider incorporating DIY climate models as core instructional tools to enhance the quality and accessibility of climate change education across disciplines. This study also highlights the potential for integrating DIY Climate Change Kits into national teacher preparation standards, particularly for non-science majors who often receive limited exposure to climate science. The DIY model kit together with the inquiry approach supports the development of systems thinking and scientific reasoning—competencies emphasized in sustainability education frameworks.

LIMITATIONS

This study is limited by its small, purposive sample; the absence of a comparison group; and the short intervention duration. Future studies should incorporate mixed-methods designs and longitudinal measurements of conceptual change.

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